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Central Eurasia: Space

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927Q0126A Moscow KRASNAYA ZVEZDA in Russian 17 Mar 92 p 1

[Article by M. Rebrov: "Baykonur—'Ready for Launch': The Button for Launching the Soyuz Booster Will Be Pressed Today at 1354 Hours"]

[Text] Today is the launch. It will take place on the second Baykonur launch pad ("No. 2") at 1354 hours. Our readers are already familiar with the crew of Soyuz TM-14. But a few words about the program of the joint mission. It bears the arbitrary name Mir-92. Not to be confused with the D-2 project. Mir-92 involves the flight of a German cosmonaut to our orbital station, whereas D-2 is the flight of two German astronauts aboard the American Space Shuttle.

Both projects are commercial. The spending on the part of the Germans, according to reports from the Ministry of Research and Technology, amount to about 38 million marks [DM]. Of that, DM20 million represents the cost of putting a 100-kg payload into orbit, the eight-day flight, and the return of the materials produced to Earth. The other DM18 million is for the training of the crew.

The German specialists admit that spaceflights are a pleasure that doesn't come cheap. But things become clearer through comparison. The cost of the D-2 project is much higher. It will cost 850 million. Although, it's true, that cost will be shared by a number of interested parties.

A series of 12-15 experiments is expected to be performed aboard the Mir orbital complex. A great deal of attention will be focused on materials science, biotechnology, and medicine, including observations of memory deterioration in weightlessness. The German cosmonaut will be able to bring back in the return capsule 10 kilograms of materials and samples produced in weightlessness.

Here's a detail that's not without interest. During Flade and Ewald's training at Star City, they were assisted by the space program veteran from the former GDR, Sigmund Jaehn, who, 14 years after his own flight into space, still has an excellent grip on all the fine points in terms of organization and hardware.

Our space sector seems to be gaining an increasingly solid commercial footing. And that's gratifying. But we ourselves admit that we are much more successful at solving the technical and science-related problems. Life will force us to learn. But for now, we wish success to those lifting off into space.

Pre-Launch Comments

927Q0126B Moscow KRASNAYA ZVEZDA in Russian 18 Mar 92 p 3

[Article by Col V. Baberdin, cosmonaut-researcher: "The Vityazi Are in Orbit: Our Special Correspondent Is Filing the Story From the Baykonur Space Launch Facility"]

[Text] And so, the Vityazi are in orbit. All the prelaunch nervousness and worries are behind us. The routine work in space is under way.

But I'd like to go back a day. I must admit that I've never seen such a huge gathering of the press at Baykonur. But then, it's not surprising—there were so many rumors floating around before the launch. Coming down the gangway of the airplane, I heard that supposedly the launch crews were striking. I got in touch with the launch facility's command, visited the testing grounds, spoke with some of the people. And yes, they had put forward demands associated with unresolved social problems, but a launch is something sacred. The launch facility team was performing all the preassigned engineering operations and was working day and night.

Another rumor was about Krikalev's health. The German crew member, Klaus-Dietrich Flade, gave journalists detailed explanations concerning the matter:

"I'm going to make it a point to speak in German so that I can explain everything properly. Sergey Krikalev's mission began back with Anatoliy Artsebarskiy. Krikalev was supposed to return with him (and with the cosmonaut-researcher Franz Viehboeck). But things changed: it was decided to include in Volkov's crew a representative of Kazakhstan—cosmonaut-researcher Aubakirov, who was not ready to perform a long-duration mission. A solution was found: Sergey Krikalev agreed to stay for a second mission on Mir. It was a valiant decision he made for the sake of the space program and his friends. And he did the job wonderfully."

I'm listening to Klaus, and I don't recognize him. His usual smile is gone. His face is stern, he's speaking in a military manner, crisply and curtly. And the next question is no less to the point. They asked Viktorenko how he felt about the Kazakh space program.

"I am categorically against dividing up space into Kazakh, Ukrainian, or Russian. We work in the context of the same space science program. When we are aloft, we study the state of affairs on the Caspian, the Aral Sea, the Volga, Lake Baykal. Any specialist or organization can make use of our information. Cosmonauts work for all the people. You probably notices that our crew left the old emblem on our flight suits. That was no accident. For us, it's a symbol of the friendship of nations. Space should unite peoples, not divide them. From my point of view, the notion of borders in space is absurd."

I ask Lt. Col. Yevgeniy Zhuk, department head at the Cosmonaut Training Center, to tell us about the ballistic aspects of the flight program.

"Theoretically, there's nothing very different. Of course, the absence of floating measurement complexes complicates the work. For example, now the 'dead' time in terms of communications is up to nine hours. And in that time, all kinds of contingency situations could arise. The crew will have to makes its own decisions."

And one more thing. The docking with Mir won't be as usual—at the transfer module. It will be to the service module, on the Kvant module side. Essentially, that will be experimental work for Viktorenko and Kaleri. If you remember, that's where one antennas for the docking-system automatic equipment was out of order and had to be replaced, and now it will have to be thoroughly tested and checked out in the distant and close-in segments of the rendezvous. If it doesn't work, the Vityazi will have to dock the craft manually.

"Will the crew be able to handle it?" asks Yevgeniy Ilich [Zhuk] with a smile. "If we weren't sure of that, we wouldn't have let them through to the state examinations. Viktorenko is an experienced commander. Kaleri is a wonderful engineer and a talented operator. Everything will be OK."

The successful launch and the start of work in orbit confirms all that.

Soyuz TM-14 Launched 17 March

927Q0126C Moscow KRASNAYA ZVEZDA in Russian 18 Mar 92 p 1

[Sky box on page 1, about inside article: "International Space Crew Lifted Off"]

[Text] On 17 March 1992, at 1354:30 hours Moscow time, the Soyuz TM-14 spacecraft lifted off from the Baykonur space launch facility.

The craft is being piloted by an international crew: Commander Aleksandr Viktorenko, Hero of the Soviet Union and USSR pilot-cosmonaut; Flight Engineer Aleksandr Kaleri; and citizen of the Federal Republic of Germany, Cosmonaut-researcher Klaus-Dietrich Flade.

The flight program calls for docking of the Soyuz TM-14 craft with the manned Mir complex and the performance of science experiments and research with the cosmonauts of the tenth main mission, Aleksandr Volkov and Sergey Krikalev.

The onboard systems of Soyuz TM-14 are functioning normally. Aleksandr Viktorenko, Aleksandr Kaleri, and Klaus-Dietrich Flade are feeling fine.

The docking of the space vehicles is slated for 19 March.

Biographic Data on Crew

927Q0126D Moscow IZVESTIYA in Russian 18 Mar 92 p 2

[Article by Boris Konovalov: "Cosmonaut From Germany Lifted Off From Baykonur"; first paragraph is source introduction]

[Text] **The first cosmonaut from united Germany, Klaus-Dietrich Flade, together with his colleagues from the CIS, Aleksandr Viktorenko and Aleksandr Kaleri, lifted off into space on the afternoon of 17 March aboard the Soyuz TM-14 spacecraft.**

The crew commander, Col. Aleksandr Viktorenko, is an experience cosmonaut—this is his third flight into space. He was commander of the Soviet-Syrian international crew and has worked a mission aboard the Mir orbital station. Flight Engineer Aleksandr Kaleri, a native of the city of Yurmala, graduated from the Moscow Physical-Technical Institute and works at NPO Energiya. This is his first flight into space, as it is for the German cosmonaut.

Klaus-Dietrich Flade is a professional military pilot with a university education. He is certified as a pilot first-class and a test pilot first-class. He has studied in England, as well as in Germany. In 1986, he was named to a group that was to fly aboard the American shuttles, but later he was chosen to go aloft aboard the Soyuz TM-14.

After docking with the Mir station, the international crew will conduct an extensive scientific-technical program aboard the station, and Germany has paid 40 million marks for the opportunity. That country is not only actively participating in the European Space Agency, but is also developing its own space program; in the future, work that is even more complicated and lengthy may be performed by representatives of Germany aboard the Mir orbital station.

Klaus-Dietrich Flade will return to Earth aboard the Soyuz TM-13 with a different pair of cosmonauts. Viktorenko and Kaleri will replace Aleksandr Volkov and Sergey Krikalev. Especially happy about that is Krikalev, who has been in orbit now for two missions and has been aboard Mir for almost an entire year.

Despite the fears on the part of the Germans that a mutiny among the construction battalion personnel would prevent the launch, everything went normally. The well-coordinated launch facility team sent the Soyuz TM-14 into orbit right on schedule.

Medical Experiments Begun

927Q0126E Moscow SOVETSKAYA ROSSIYA in Russian 19 Mar 92 p 1

[Article with no byline, filed from the Flight Control Center on 18 March, under the rubric "News": "International Mission"]

[Text] Independent flight continues for the Soyuz TM-14 spacecraft, which lifted off from the Baykonur launch facility yesterday. It carries an international crew—Aleksandr Viktorenko, Aleksandr Kaleri, and a guest from Germany, Klaus-Dietrich Flade. Everything is going as planned. The cosmonauts have begun the medical experiments. A one-impulse maneuver for the rendezvous of the spacecraft with the long-duration Mir facility has been performed.

Docking is scheduled for 19 March. The linkup of the spacecraft and the station should take place at 1533 hours Moscow time, and the opening of the transfer hatch and meeting of the crews are expected at between 1700 hours and 1715 hours. A television spot titled "The Meeting" is to take place at that time.

Soyuz TM-14 Docks With Mir Complex

927Q0126F Moscow KRASNAYA ZVEZDA in Russian 20 Mar 92 p 1

[Article by Col. V. Baberdin, cosmonaut-researcher: "1533 Hours—The Docking Is Complete: Report From the Flight Control Center"]

[Text] I remember how, at Star City, after the meeting of the State Commission, Viktorenko, while accepting congratulations on being confirmed as commander of the main crew, slyly smiled and whispered to me:

"This is all nonsense. It's just another step, it's done, let's go on to the next. But when I find myself in a real craft, when I hear the flight director's voice in my headsets, when I see the console in front of me, and the cone and the target of the docking port of the station, that's when I'll believe that I'm in space..."

It seems that Viktorenko's dream has certainly come true now. The Vityazi are in orbit.

On the huge screen in the main hall of the Flight Control Center, against the backdrop of maps of the Earth, are two small glowing spots. They're moving along a designated trajectory, gradually nearing each other. Under way is the docking of the Soyuz TM-14 transport craft and the Mir orbital station. It's a very complicated processing involving the interaction of automatic and telemetry system, Flight Control Center specialists, and, of course, crew members.

On the Flight Control Center's PA system I can hear clearly the conversations with the Vityazi. Everything is going as planned so far. At 1325:43 hours, the first impulse is performed. On the next orbit, at 1410:20, the second impulse. Forty minutes later, the third. And now the automatic units of the Soyuz TM-14 have locked-on to the Mir antennas. 400 meters, 300 meters.... The command to dock is given.

Yes, how many such dockings have there been, with Soyuzes and Progresses. I can't help but wonder if we all realize what vast experience we have, what wealth we have in our possession. Can it even be measured in rubles, or dollars, or marks? After all, it's no accident that almost all of Western Europe is represented at Star City, in our cosmonaut corps. The flights of a British cosmonaut, a Austrian cosmonaut, a German cosmonaut, a French cosmonaut—they certainly haven't been joy rides. They've consisted of serious, carefully balanced, intense work in orbit. Not just up-and-then-down flight, but research thought out over years.

For Flade, his stay aboard the orbital complex is scheduled literally to the minute. The research involves, primarily, the study of the effects of weightlessness on the human body. The experiments are original. We've never done any like them. The Germans started them last year aboard the American shuttle, and they'll continue them next year, during a German mission, again on the shuttle. They're also willing to collaborate with us over the years, but we just need to think about what shape that collaboration will take.

What is it that we have that attracts them? It's not just the price of the flights. It's also the reliability. Plus our knowledge and experience. But we ourselves can't rest on that. We have to move ahead. We have to be vigorous in conducting our own scientific research, in perfecting our ergonomics, in improving the equipment on our spacecraft and stations. We have to realize the whole of our accumulated potential. But once again, there's no capital. Space firms are underloaded and are going through conversion painfully. Conversion demands ever newer capital investments. It's a vicious circle. We have to break it somehow, or else lose our serious foreign partners. They'll reach out level and then...keep going, independently, without us.

At 1533 hours, on the screen of the Flight Control Center board is a video image. You can clearly see the orbital station growing larger, drawing closer. You can already see the cone of the docking assembly. An instant later, mechanical lock—we have docking.

Research Continues, Soyuz TM-13 Prepared for Return

927Q0126G Moscow SOVETSKAYA ROSSIYA in Russian 24 Mar 92 p 1

[ITAR-TASS wire: "The Flight Continues"]

[Text] Joint operations continue aboard the Mir complex in the international flight program and the transfer of the watch to the crew of the eleventh main mission.

Aleksandr Volkov and Sergey Krikalev have begun preparing the Soyuz TM-13 for reentry.

Another series of medical experiments are planned for Klaus-Dietrich Flade. Aleksandr Viktorenko and Aleksandr Kaleri are continuing to settle into the orbital laboratory.

Volkov, Krikalev, Flade Return to Earth

927Q0126H Moscow SOVETSKAYA ROSSIYA in Russian 26 Mar 92 p 1

[Article with no byline: "The Cosmonauts Are on the Ground"]

[Text] Yesterday, at 1151 hours Moscow time, after completing their planned research on the manned Mir complex, Aleksandr Volkov, Sergey Krikalev, and Klaus-Dietrich Flade made their return to Earth.

The return capsule of the Soyuz TM-13 landed in Kazakhstan 65 kilometers northeast of the city of Arkalyk.

'Progress M-12' Launched 20 April

LD2004051292 Moscow ITAR-TASS World Service in Russian 2340 GMT 19 Apr 92

[Text] [No dateline as received] In accordance with the plan for further operations by the Mir scientific-research complex, the Progress M-12 automated cargo craft was launched at 0129 Moscow time on 20 April. [2129 GMT 19 April]

The craft has been sent to deliver consumables and various supplies to the Mir manned complex.

The parameters of Progress M-12's orbit are:

—maximum distance from the Earth's surface—230 kilometers;
—minimum distance from the Earth's surface—193 kilometers;
—one revolution per 88.4 minutes;
—inclination—51.8 degrees.

According to telemetric data, the automated cargo craft's on-board systems are functioning normally.

Rumors of Cosmonaut Krikalev's Post-Flight Medical Problems Denied

927Q0127 Moscow IZVESTIYA in Russian 4 Apr 92 Morning Edition p 7

[Article by Sergey Leskov: "The Doctors and Wife of Cosmonaut Sergey Krikalev Deny Rumors of His Being Ill"; first paragraph is source introduction]

[Text] **In recent days, the editorial office's telephone has been ringing off the wall with calls from our colleagues from the foreign mass media. The question has been the same: Is it true that a week ago, Sergey Krikalev, who recently returned from a yearlong space mission, got seriously ill?**

For an explanation, this IZVESTIYA correspondent turned to the people who know better than anyone else how cosmonaut Krikalev is feeling.

In the opinion of Dr. Med. Sci. V. Polyakov—who himself performed a lengthy spaceflight several years ago and is now directly responsible for the health of S. Krikalev—the physical condition of his ward is not at all a cause for concern and is appropriate for the length of his supermarathon in space. The rate at which he is recovering is also meeting medical expectations. Sergey Krikalev is swimming a lot in a pool and is taking longer walks everyday, with the walks now up to 15 minutes long. For now, the doctors are now allowing the cosmonaut to run.

One remembers, however, that one individual who took part in a previous long-duration mission, M. Manarov, also made it through the rehabilitation period successfully, but later ended up in the hospital for a long time. Could it be, perhaps, that weightlessness affects the health of the individual in some way that is not understood by the doctors and that shows up after some longer interval of time? Academy of Medical Sciences Corresponding Member A. Grigoryev, who is director of the Institute of Biomedical Problems, does not exclude such a possibility, but he emphasizes that Manarov's illness was in no way associated with spaceflight. According to Grigoryev, Krikalev exhibited vestibular apparatus problems at first, but everything is normal now.

Yelena Krikalev, the cosmonaut's wife, goes to Star City everyday. A woman's heart, as we all know, can't be deceived, and Yelena thinks that Sergey is feeling pretty good in fact, although he did get about five pounds thinner during the flight. The only misfortune that, in Yelena's words, is following her husband around is the rumors. When Sergey was in orbit, there was talk from nobody knows where about his not feeling well. On the ground, it's the same story.

Finally, the opinion of Sergey Krikalev himself. "A week after returning to Earth, the way I feel is no different from the way I felt after my first long-duration mission," the cosmonaut told this IZVESTIYA correspondent. A confirmation of his good physical condition is the fact that Krikalev and crew commander A. Volkov spend several hours a day working with specialists to analyze the results of the space mission.

Report From Cape Canaveral on U.S. Shuttle Launch

927Q0121 Moscow IZVESTIYA in Russian 26 Mar 92 First Edition pp 1,3

[Article by Boris Konovalov, from the state of Florida: "An Open Space Launch Facility: For the First Time, a Correspondent From Russia Reports on a Launch Direct From the American Launch Facility at Cape Canaveral"]

[Text] I flew here at the invitation of AVIATION WEEK AND SPACE TECHNOLOGY, the most widely read magazine in the aerospace world. By the way, it's the same age as IZVESTIYA. In the modern Orlando International Airport, we were not met by security service, as used to be the case in the [Soviet] Union, and still is in the CIS.

In the press registration building, my "hammer and sickle" passport with the emblem of the nonexistent Soviet Union did not evoke any shock. Within a couple of minutes, a smiling young black woman issued me a registration card and pass. And just for the information of the Kazakhstanis, who are getting ready now to charge journalists, especially foreign journalists, a lot of money to register at Baykonur, I should report that no one took a cent from me here for this.

The flight of the Atlantis, which is part of the Mission to Planet Earth program, is an international flight, and the United States is not taking any money for it, even though it costs nearly $350 million. The cargo bay of the Atlantis holds equipment developed by countries that are part of the European Space Agency and by Japan. It costs more than $50 million. But it will return to Earth and may be used as many as 10 times. Ten more flights of the Space Shuttle series are expected, to study in more detail the effect of the 11-year solar cycle on the processes occurring in the Earth's atmosphere, ionosphere, and magnetosphere. The European Space Agency is represented in the crew by the first Belgian cosmonaut, Dirk Frimout. He's going up free of charge—the project is important for all mankind.

The crew of the Atlantis consists of seven people and is headed by the dark-complexioned Col. Charles Bolden. There is no backup crew. The crewmembers learned more than a year ago that they would go be going up, and they did their best to look after their health. We always prepare two crews. And it isn't until two days before the launch that the State Commission makes the final decision about who will go up and who will stay on the ground.

The Americans flew to the space launch facility not two weeks ahead of time, like we do, but three days ahead of time. And they flew in themselves in two-seater training aircraft. They gave mini—interviews to the journalists right here, at the airport. And then they all went to their families, who were there to meet them.

When I got a look at the seven astronauts standing on the concrete of the American launch facility, I was stricken by one thing. One of them, the woman, Kathryn Sullivan, was wearing glasses. Our medical people would shoot themselves before they would allow someone who wore glasses to go aloft in space. Meanwhile, Kathryn has already been in orbit twice before. She's done EVA work, and when she was aboard the Shuttle, she helped launch the world's largest extraatmospheric telescope, the Hubble. This is her third flight. She's going into the Guinness Book of Records.

There are both military and civilians in the Atlantis crew. And the launch facility at Cape Canaveral itself has two functions. Part of the grounds belong to NASA, and the rest, to the Air Force and the Navy. The security guards at Cape Canaveral aren't idle. When we took pictures of the Saturn 5 lunar rocket with tourists all around it, an officer stopped us. We had broken the regulations—without an escort, we weren't permitted to walk around outside the press area. We had to get things straightened out at the press center. Then, to everyone's delight, we had our pictures taken with the officer. It turned out he was armed in a serious way—he had not only a high-powered pistol with two extra clips, but also an automatic weapon in the car.

It's surprising that our country stayed successfully in the space race for so long. We proved that or scientists and engineers are not inferior to the Americans. And it's not true when they say that the Energiya-Buran complex was copied from the American Space Shuttle. Our engineering schools are different, and we have different design approaches.

Rarely does any Space Shuttle launch go off without a hitch. And that's understandable. It's probably the most complex technical system around today. The launch that I witnessed was no exception. It was postponed a day. At midnight, when fueling operations got under way with liquid oxygen and hydrogen, the instruments detected the presence of gaseous hydrogen. Together with oxygen, that's a "volatile mix"—one spark, and it explodes.

At the morning briefing, the journalists were told in detail what had happened. Work with the press at Baykonur is strikingly different from here. Essentially, at all our space facilities and at the flight control centers, no one takes seriously the idea that the public should be informed or that the work of the journalists should be well taken care of, so they can explain to the tax payers where their money is going and of what benefit the space programs are.

The general public doesn't understand why we have such an exultant tone in covering spaceflights. But it's simply that there are censors sitting at both "ends" of the teletype—at the launch facility and in Moscow. Then can scratch out virtually anything they want to scratch out. And if anything makes it to the editorial offices, its censored copy. It's not surprising that after the censorship was lifted, the exulting tone changed to a condemning tone.

At the launch facility at Cape Canaveral, journalists have their own observation point. Right next door are the press center and a hall for briefings and press conferences. And not far away is a combined press center for industrial firms, where they give you exhaustive information. Next to the observation point, the leading television companies and agencies have built their own cottages, from where they do their reporting. Many newspapers and magazines have their own telephones in the press center. And right there are representatives of NASA headquarters and of all the centers of that agency. There are oral briefings and printed material on open stands as a service to the journalists. There's a huge library of photographs. When you find what you need, you can order any of it by number for your publication. There are communication links with the entire world.

In seeing all this sensibleness, I haven't once been reminded of how we work at Baykonur. Even television and radio - the only ones who could do reporting directly from the launch site - do not have a permanent pavilion there to date. And newspaper people have to scramble along a narrow, bumpy road for about an hour to get to Leninsk to get to that longed for telephone.

But his report I send to the editorial office by telephone right after the launch. That's how things compare.

I took a liking to one of the few slogans floating around Cape Canaveral. In Russian, it goes roughly like this: If you have a dream, make it happen. We dream about better times. And don't make that previous, immense mistake - don't raze everything to the ground. Our space program is our national treasure. There'll come a time when we'll be proud of it again, the way Americans are proud of theirs.

Report on U.S. Shuttle Mission From Houston Flight Control Center

927Q0122 Moscow IZVESTIYA in Russian 31 Mar 92 First Edition p 2

[Article by B. Konovalov: "They Pay Well in Houston, But They Don't Make Heroes: Report From the American Flight Control Center in Houston"; first paragraph is source introduction]

[Text] **On the Flight Control Center board right now, two images are moving in their separate trajectories—one of the American Atlantis, the other of our Mir orbital complex. The astronauts and cosmonauts have contacted each other and sometimes have maintained that contact as they do joint work.**

In our Flight Control Center near Moscow, I've never seen any display of the activity of American spacecraft. It's as if it has nothing to do with us. During the Cold War years, we heard about American flights only if there was some sort of problem or an accident at launch. The Americans, too, were more objective then, and now they relate to our space program with respect.

Almost all the newspapers here reported the landing of the Soyuz Tm-13. Many carried photos of Sergey Krikalev, noting that after 10 months aloft, he was returning to a different country, a different world.

In that different world, which is free of censorship, one can finally compare the situation involving the space centers, the situation involving the people who have devoted their lives to the space program both in our country and in the United States.

In Houston, you don't just have the Flight Control Center—you also have the NASA Space Center named for President L. Johnson, who did much to create it. It's an integrated center in that, were it in our country, it would include the Flight Control Center, Star City, and the Institute for Biomedical Problems. In addition, design work is also done here. And many hundreds of thousands of people pass through the excellent museum here every year. And if that isn't enough, a commercial consortium is building a new museum complex.

In Star City, the foundation for the museum was laid about 10 years ago, but nothing has been done since then. To this day, the museum takes shelter in three small halls in the House of Culture. And that's not because of any secrecy—it's just the standard neglect of the interests of the population.

In Houston, they respect the taxpayer. Local Channel 1 broadcasts everything that happens in the Control Center during the flight. In the space center cafeteria, tourists dine alongside NASA staff members and astronauts, something that attracts people no less than the museum exhibits. In our country, the space films gather dust on the shelves; here, they show them everyday in a huge museum room. Operations involving the assembly of the international space station Freedom aren't slated to begin until 1995, but in the simulator building, they've already built a mockup that tourists can peek into (in Star City, mere mortals aren't even allowed into the building). When there's no mission aloft, tourists are even shown around the Flight Control Center itself.

Just before I flew here to the United States, I was at our Flight Control Center, and I learned that a strike committee had been created there—the staffers were unhappy with their pay and the difficult working conditions. Most of our specialists work three shifts round the clock. They work 24 hours and then try to get some rest for the next two days. And for that difficult, very crucial work they get an average of 1200-1300 rubles a month. The Americans have five shifts, and they work nine hours. One hour is given over to shift change. And they get an average of $2000-3000 a month. Taxes take about 20 percent. The maximum tax is 28 percent. That same 28 percent they take from us for everything is, as they say, just the beginning.

Flight director in our country is a special post. Initially, it was filled by A. Yeliseyev, and then V. Ryumin, and now V. Solovyev. All of them are cosmonauts—twice decorated as Heroes of the Soviet Union. In Houston, flight director is a working post. There are 12 flight directors in all here. Each of them prepares long for his flight and knows all about the program right down to the fine points. I was told that by the director of the next Shuttle flight, [?Cranville?] Rennington. He is scheduled to direct the flight of the Endeavor, which was built to replace the exploded Challenger. He is regarded as the most experience flight director there. He has worked in Houston for 25 years now, and they've entrusted him with the directorship of the flight of the new spacecraft.

Rennington proudly wears a NASA gold medal on his tie—with three stars symbolizing the sky and a stylized image of a spacecraft lifting off into space. Such medals are awarded to astronauts and outstanding figures at NASA. There aren't any heroes at NASA. True, military

people are promoted to the next rank after a flight. But they don't get any kind of additional award for their work in orbit.

We were able to stay in the space race for a long time simply because we paid our specialists a beggarly wage, and as a result materials and instruments cost much less than the world prices. We hung in there on enthusiasm and pride in our country. That country that held on by robbing the people is no more. But living in the new country isn't any easier, it's harder. Nevertheless, of the little with which we can enter the world community as an equal, there's the space program.

In operation aboard the Atlantis is a huge complex of instruments, and more than 10 interesting experiments are being conducted in the context of the study of the various shells around our planet. The program was prepared not just by the United States, but also by Belgium, France, Germany, Switzerland, Japan, and Holland. Under way now is the International Space Year, and without it, science and many spheres of human activity would be unthinkable. And it's good that our country, the first to go into space, is continuing to participate in it.

Central Committee Archive Documents on Gagarin Flight Cited

927Q0117 Moscow KRASNAYA ZVEZDA in Russian 28 Mar 92 p 3

[Article by M. Rebrov, under the rubric "Special to KRASNAYA ZVEZDA": The Difficult Path to April 1961, or Why We're Not Finding Out the Entire Truth About the Flight of Yu. Gagarin Until Today"; first three paragraphs are source introduction]

[Text] **Today, we have access to documents from the archives of the General Department of the CPSS Central Committee about the space vehicle Vostok-3A, documents that were kept in strict secrecy for many years. The documents relate to one the greatest events of the century—the first flight of a man in space.**

The cruise among the stars of Yuriy Gagarin shook the world. At first the planet was in shock, then there was a storm of ecstasy, but there was probably not much comprehension of the event. There were a good many lies, a lot of conjecture, and a lot of gossip. Maybe none of that would have happened if, from the very outset, we had known the whole truth about how we got to that memorable day, April 12, 1961. I am convinced that the concealment didn't bring us any glory or any authority, and no secrets were protected. But we lost a lot. We kept quiet about the difficult, thorny path that led to the achievement of mankind's centuries-old dream, and we kept quiet about the heroism and courage of creative people.

The documents with which I recently became familiar bore the stamp "Top Secret," with the added words "Special File." That was a sign of the times. In fact, many documents surprise us—what with the supersecrecy that was maintained so long and was taken to absurdity. But there are also some that do actually reveal things we didn't know.

It turns out that the first official word involving specific suggestions to explore space dates back to 1954. It was a report memorandum from S. P. Korolev to the government, and it spoke of a design by engineer M. K. Tikhonravov. Korolev was careful with his words not to reveal any actual nomenclature.

"The study done thus far of a new article enables us to entertain the possibility of creating an artificial Earth satellite in the next few years...it would be timely and advisable to set up a research division for conducting the initial basic research for the satellite and for performing a more detailed study of the questions associated with that problem..."

Those in the government reacted to the designer's request in various ways, but a decision was made on it, and 4 April 1957 became the beginning of the space age of man. After that, the events unfolded like this: as early as April 1958, a detailed analysis of the design of a [manned] spacecraft was under way; in May, the calculations were done; and by late 1959, a plant had built the first model of the spacecraft. And they didn't just throw it together—they built it to be very reliable.

And so, three years went by after 4 October. On 19 September 1960, the General Department of the CPSS Central Committee received a memorandum signed by D. Ustinov (a Central Committee member and the chairman of the USSR Council of Ministers), R. Malinovskiy (a Central Committee member and the minister of defense), K. Rudnev, V. Kalmykov, P. Dementyev, B. Butoma, V. Ryabikov (USSR minister), M. Nedelin (commander in chief of the Strategic Rocket Forces), S. Rudenko (deputy commander in chief of the air force), and M. Keldysh (vice president of the USSR Academy of Sciences), as well as by a group of chief designers—S. Korolev (OKB-1), V. Glushko (OKB-456), M. Ryazanskiy (NII-845), N. Pilyugin (NII-885), V. Barmin (State Special Design Bureau for Special Machine Building), and V. Kuznetsov (NII-944). In the Central Committee's General Department, the document was stamped "Top Secret/Special Importance," with the note "Copy No 1." Here is what it said:

"The successful launch, space flight, and landing of the spacecraft (article 'Vostok-1') sheds new light on the dates for performing a manned flight into space...

"An analysis of the designs outlined suggests the possibility of building the spacecraft (article 'Vostok-3A') and sending a man into space on that spacecraft in 1960...

"As already reported to the CPSS Central Committee, a rocket system has already been prepared—the 8K78 launch vehicle, which is capable of an Earth satellite weighing 7-9 tons into orbit...

"Based on that, the following proposals are made...to perform a manned flight...in December 1960..."

On 11 October 1960, a decree stamped "Top Secret/ Special Importance" left the CPSS Central Committee and the USSR Council of Ministers.

"...The suggestion is adopted...concerning the preparations and launch of the spacecraft (article 'Vostok-3A') with a man aboard, in December 1960, his mission being of special importance..."

Don't gallop past those little lines, reader. In-between them is a sensational story of sorts. It turns out that what shook the world on 12 April 1961 had been planned for December 1960. So the question immediately comes to mind, Then why was the date for the flight changed?

On 24 October, at Baykonur's pad No 41, during the launch preparation of the new rocket developed in M. Yangel's design bureau, there was an explosion. The tragedy at the launch facility took dozens of lives. Among those killed was Chief Marshal of the Artillery M. I. Nedelin.

The government commission headed by L. Brezhnev began an investigation to determine the causes of the event, but only a little over a month was left before the "stipulated" December. The launch of Vostok-3A was shifted.

"30 March 1961/Top Secret/Copy No 1/CPSS Central Committee:

We report that...a massive amount of research, experimental design, and testing has been done on the ground and in flight...

A total of seven launches of the Vostok satellite craft have been done: five launches of Vostok-1 and two launches of Vostok-3A.... The results of the work done to perfect the design of the satellite craft and the reentry systems and to train the cosmonauts make it possible at present for us to perform the first manned flight into space.

Six cosmonauts have been trained for the flight(Yu. Gagarin, G. Titov, A. Nikolayev, P. Popovich, V. Bykovskiy, and G. Nelyubov—M. Rebrov).

In the orbit chosen for the satellite craft, if the landing system fails, the craft will descend as a result of natural braking in the atmosphere over a period of two-seven days....

In the event of a forced landing on foreign soil or the rescue of the cosmonaut by a foreign vessel, the cosmonaut has the appropriate instructions about what to do...."

The memorandum was signed by D. Ustinov, K. Rudnev, V. Kalmykov, P. Dementyev, B. Butoma, M. Keldysh, K. Moskalenko (he took Nedelin's place), K. Vershinin (deputy commander in chief of the air force), N. Kamanin (deputy chief of combat training of the air force), P. Ivashutin (first deputy chairman of the KGB), and S. Korolev.

The question may arise, How did Ivashutin get in there among the signers of the memorandum? The answer is most probably buried in the part of the memorandum that say this:

"We think it advisable to broadcast the first TASS report immediately after the satellite craft goes into orbit for the following reasons:

(a) if the need arises, it will facilitate the rapid organization of a rescue effort

(b) it will preclude any sort of foreign state declaring the cosmonaut a military reconnaissance scout...."

On 3 April, the CPSS Central Committee Presidium adopted a decree called "The Launch of the Satellite/ Spacecraft." The upper righthand corner bore the words "Secret. Special File." After that was a two-paragraph text:

"1. Approve the proposal of comrades Ustinov, Rudnev, Kalmykov, Dementyev, Butoma, Moskalenko, Vershinin, Keldysh, Ivashutin, and Korolev concerning the launch of the satellite/spacecraft Vostok-3A with a cosmonaut aboard...."

Subsequent events unfolded like this. On 4 April, Korolev reported to the government commission (it convened at Baykonur) concerning the level of readiness in terms of the first flight of a man into space. On the morning of 6 April, Korolev assembled the Council of Chief Designers. Initially, the meeting involved purely technical matters, and aspects of the prelaunch preparations of the booster and the spacecraft were discussed. Then matters moved to compiling the flight assignment for the first cosmonaut.

The fueling of the rocket got under way in the morning. Tanks clanged of iron. The loud speaker system was crackling. The noise of the pumps was like the moans of a whale stuck in mud. The launch crews bustled at various levels on the metal framework.

At 0710 hours, on the VHF, communications with the cosmonaut began, through the radio station with the call name Zarya-1. A complete transcript of the communications, referenced to hours and minutes, was intended for official use only. It ends with this entry:

"1018 hours. VESNA (representative of NII-N of the ministry of defense, Capt. V. I. Khoroshilov): Major Gagarin, your flight is proceeding well—(no answer followed)."

The "special file" preserves another curious document—"Entry made by the cosmonaut on the onboard ZB-24 recorder No 008 during the flight of the Vostok spacecraft on 12 April 1961." It begins with the Gagarin's famous words, "Let's go!"

On 13 April, in Kuybyshev (now Samara), the State Commission convened on the results of the space flight. Gagarin reported in detail about all the stages of his trip. Until recently, the record of the report bore the classification "Top Secret." Copy No 1 was signed by Gagarin himself. That same Top Secret classification was also on the 10 pages attached to the report—questions asked of the cosmonaut, plus his answers. Both documents Chief Marshal of Aviation K. S. Vershinin submitted to the CPSS Central Committee on 19 April 1961, with a brief accompanying note. It has this marked on it: "Reported to Comrade Khrushchev, 21 April 1961. Shuyskiy."

Those unique testimonies to history, however, are remarkable for another reason. You have to know Gagarin, his strong will, and his attitude to what was assigned him to understand fully how responsibly he approached the performance of his job and the interpretation of what had happened and to understand his ability to assess a situation in the finest detail and make good decisions.

Gagarin got into the spacecraft. When they closed the hatch, it was discovered that there was no signal confirming the seal. The lead designer for Vostok and the launch crew corrected the problem in a matter of minutes. Gagarin was aware of what had happened, but that didn't affect his readiness for launch.

Then there was the launch, the injection, the sequential firing of the booster stages, vibrations, g-loads, weightlessness, the flight itself, and, finally, reentry. Right here I want to present, word-for-word, what the cosmonaut was feeling.

"When the light went out with the transmittal of the third command, I started watching the pressure in the RRS (retrorocket system—M. Rebrov) *and the attitude-control system. It started to drop swiftly.... I could feel the RRS kick in. You could hear a buzzing and a noise through the frame.... The g-loads were growing.... At that moment, the needles for the automatic attitude-control system and the RRS tank jumped to zero at the same time.... The craft began to rotate...at a very high rate.... I was just barely shutting the Sun out, so I could keep the light out of my eyes. I put my feet up to the viewport, but I couldn't close the shutters. I was wondering what was going on. I knew that, according to the calculations, it was supposed to happen 10-12 seconds after the cut-in of the RRS.... But it felt like more time had passed than that, and there was no separation. On the instrument panel, the 'Spusk 1' [Descent 1] light was still on, and the 'Prepare for ejection' was not on. The separation wasn't taking place.... I decided that something was wrong.... I figured I'd land one way or other.... somewhere before the Far East I'd land.... I transmitted an EN—everything normal....*

"The spacecraft is beginning to turn slowly, about all three axes. It began to swing 90° to the left and right.... I could sense the oscillation of the craft and burning of the coating.... I could feel the high temperature.... Then the g-loads began to grow smoothly.... The g-load felt to be more than 10 g. Things started turning a little gray. I squinted and strained again. That helped, and everything sort of went back in place."

And here's another bit of evidence that indicates that we didn't know the whole truth. The TASS report suggested that the cosmonaut landed with his craft. That version acquired the force of truth, but the true story was glazed over for many years. Why? I don't know. The flight program called for a landing away from the craft. And that didn't take away from the heroism of the cosmonaut or the magnitude (so to speak) of the design idea. The Americans couldn't duplicate orbital flight until 20 February 1962. J. Glenn put down in the ocean, which, by the way, is technically much simpler. For Gagarin, ejection and descent by parachute were yet another test of will and courage. He passed the test.

When the command for reentry went up, Korolev phoned from Baykonur to Pitsunda, where Khrushchev was. The connection was bad: Korolev pressed close to the receiver and yelled, "The parachute has opened, and he's landing. The spacecraft seems to be OK!"

Khrushchev yelled in reply: "Is he alive? Is he sending signals? Is he alive? Is he alive?..."

And here's what happened during that leg of the flight:

"...I'm waiting for ejection. At that time, at an altitude of about 7,000 meters, hatch No 1 fired. There was a pop, and the hatch flew away. I'm sitting and thinking: it didn't eject me? So, I carefully looked up. At that moment, it fired, and I was ejected.... I went out with the seat. The cannon fired again, and the stabilizing parachute was deployed.... Then the reserve parachute went out, it went out but hung. So it didn't open. Just the pack opened...."

And, as it turns out, we didn't known anything of that malfunction at the end of the flight. Nor did we know of Gagarin's words: "It's hard, but I can stand it."

The reader would be right to ask, Why so many ellipses in the text? I presented the content of the documents, with some abridgements. They were made only because there's not enough space in the newspaper to present these interesting documents in their entirety.

And last of all, regardless of what is said about the Gagarin flight, a remarkable event in the history of our country took place in April 1961. And not just in our history. Without exaggeration, one can say that it was a remarkable event in the history of all human civilization.

Evidence Said to Exist for Unreported Deaths of Cosmonauts

927Q0068A Moscow NEZAVISIMAYA GAZETA in Russian 18 Jan 92 p 6

[Article by Aleksandr Bolonkin: "Lost in Space. Secret Pages in History of Soviet Cosmonautics"; the first four paragraphs are the introduction]

[Text] Aleksandr Bolonkin, doctor of technical sciences, worked in the Soviet aviation and rocket industry, as well as in institutions of higher education linked by contracts to the aerospace industry, about 30 years.

Today he lives in New York. In 1991 his book "Development of Rocket Engines for Strategic Missiles" was published in English in the United States.

A. Bolonkin is president of the American section of the International Society of Former Soviet Political Prisoners.

The material published below is part of a lengthy article entitled "Secrets of the Soviet Rocket and Space Industry," which the author made available to NEZAVISIMAYA GAZETA.

Rumors and stories concerning the death of Soviet cosmonauts have constantly circulated among workers in the aviation and rocket industries. I will cite some of them.

The flier Ledovskikh perished in 1957 during a suborbital flight at the Kapustin Yar cosmodrome in the Volga region. The next year the flier Shaborin was lost in a similar way, and in 1959—the flier Mitkov.

In 1960 a spaceship with a cosmonaut was incorrectly put into orbit and he died. The last name of the cosmonaut still remains unknown.

In September 1960 a booster rocket with the cosmonaut Petr Dolgov aboard exploded on the launch pad.

In early April 1961 the flier Vladimir Ilyushin flew around the planet but suffered an accident upon return to the Earth. In May 1961 weak signals with a call for assistance were heard in Europe. There is basis for assuming that the signals emanated from a Soviet spaceship which had experienced misfortune.

On 14 October 1961 a spaceship went off course and perished.

In November 1962 Italian radio amateurs picked up signals from a perishing spaceship. It is assumed that the last name of the cosmonaut was Belokonov.

On 19 November 1963 a ship piloted by a woman was launched. The flight ended in tragedy.

According to CIA data, up to 1967 at least five Soviet space flights ended in catastrophe and not less than six accidents with casualties occurred on the ground.

The communist leadership of the USSR categorically denied reports concerning these catastrophes. Probably not all this information, not all these rumors are reliable. But many facts support them. For example, in a comparison of the very same official photographs published by the authorities at different times it is possible to note that some cosmonauts have been skillfully painted out—they have simply disappeared from the photographs and have been replaced by a background.

On one of the collective photographs among the 16 portrayed cosmonauts only 11 later remained! The following had disappeared: Grigoriy Nelyubov, Ivan Anikeyev, Valentin Filatov, Mars Rafikov, Dmitriy Zaikin, as well as the parachute instructor Nikitin, who perished during the time of a jump.

During the time of preparations for the Soyuz-Apollo mission in 1973 the cosmonaut Shatalov told his American colleagues that six-eight cosmonaut candidates had died. That same year a woman who was part of the Soviet delegation visiting NASA declared that she was the widow of the cosmonaut Anatoliy Tokov, who died in 1967 during preparations for a space flight.

Claim of Early Unreported Deaths of Cosmonauts Denied

927Q0081A Moscow NEZAVISIMAYA GAZETA in Russian 19 Feb 92 p 5

[Article by Yaroslav Golovanov: "Mountain of Corpses in Space; 'Secret Pages in History of Soviet Cosmonautics' Was Written by Liars"]

[Text] NEZAVISIMAYA GAZETA, which I very much respect, on 18 January published excepts from a "lengthy article" by Aleksandr Bolonkin entitled "Secrets of the Soviet Rocket and Space Industry." The excerpt is called "Lost in Space." You will agree that it is completely impossible not to read an article with such a title.

I read. It says there that according to CIA data during a 10-year period (1957-1967) at least five space flights in the USSR ended in catastrophe and not less than six accidents with casualties occurred on the ground. I always considered the CIA to be well versed and solid to the highest degree and I simply refuse to believe that it could publish such a thing. During the mentioned period we had far more accidents both in space and on the ground and the count is probably in the dozens. Precisely during that period a "good tradition" took firm root: if some space object, such as an automatic station, intended for flight to Venus, entered into an earth satellite orbit and then did not want to fly or did not fly where it was intended, it was announced to be a satellite of the Cosmos series and no one was the wiser. Indeed, the fellow who thought up the phrase for this series "in the interests of the further mastery of space" was truly quite a chap because this series was transformed into a gigantic crowd of both well-functioning satellites and all possible kinds of broken, crippled objects and vehicles having no relationship whatsoever to orbital flights. If a space vehicle did not enter orbit, not having gained the necessary velocity, or exploded on the ground, and therefore could not be intersected by tracking radars, nothing was reported about it at all. The only exception was one Soyuz ship launched on 5 April 1975 with the cosmonauts Vasiliy Lazarev and Oleg Makarov aboard. In actuality it did not enter into orbit: the third stage failed.

So, from 1957 through 1967 in space (to be more precise, in near-Earth space) one Soviet cosmonaut perished—Vladimir Komarov, on 24 April 1967; on the ground—one of the members of the first cosmonaut detachment—Valentin Bondarenko, as a result of a fire in an anechoic-pressure chamber with an excess atmospheric oxygen content, on 27 January of this same 1967. And that's it! So now let the CIA enter that in its computers.

Next in the excerpt it is stated that the flier Ledovskiy died at the Kapustin Yar test range in 1957, during an orbital flight. In 1958 the flier Shaborin died and in 1959 the flier Mitkov.

S. P. Korolev examined the idea of a suborbital flight in which a cosmonaut flies in a ballistic trajectory, but not having the necessary velocity, describing a gigantic arc, descends to the Earth. Sergey Pavlovich for some time was even fascinated by this idea (the necessary calculations were made in his design bureau), but he soon cooled toward it. The largest rocket which was launched in these years at the Kapustin Yar test range was the R-5 rocket, by means of which in theory it was possible to make a suborbital flight similar to those two suborbital flights which were made by Alan Shepard in May and Virgil Grissom in July 1961 after the flight of Yuriy Gagarin. Both these flights lasted about 15 minutes. Yes, in theory this could be done, but this was not done! Not one cosmonaut was ever launched from the Kapustin Yar test range in the R-5 or in any other rocket.

Next in the excerpt it mentions Petr Dolgov, who supposedly died in September 1960. Yes, Petr Ivanovich Dolgov did die, but not in September 1960; he actually perished on 1 November 1962 during a parachute jump from the stratosphere (altitude 24,500 m) as a result of spacesuit depressurization. Among the victims of space in April 1961 the author of the excerpt lists Vladimir Ilyushin, the son of the famed aircraft designer, who is now alive and well. Both he himself and journalists already more than once have told that on the morning of 8 July 1960 when he headed for the airfield a drunken bunch in a truck hit his car "head on." The motor, torn from its mountings, smashed both legs of the celebrated test pilot. He was treated in Moscow, and later in China, whence originated the myth of a catastrophe during a space flight of Ilyushin, who never spent one day in the cosmonaut detachment.

The excerpt also mentions several dates of the destruction of Soviet manned ships. 14 October 1961: on that day we launched nothing at all and only earlier launched satellites were in orbit. The next launching was that of an unmanned Cosmos, which took place once again at Kapustin Yar on 21 October. The satellite did not enter orbit. So what human victims were involved here? On 19 November 1963 a ship with a female cosmonaut was supposedly launched. Again a scrub. The Cosmos-21 and Cosmos-22 were launched on 11 and 16 November. The Cosmos-22 was evidently an experimental spaceship: the weight was similar—4780 kilograms. After six days it landed on the Earth. There was no crew in this vehicle. It is simply boring to refute all this.

I conversed with one of the pioneers of our cosmonautics—Hero of Socialist Labor Semen Mikhaylovich Alekseyev, who in the years of interest to us and to the CIA headed a design bureau in which flight and space suits and the first life support systems were fabricated. "The loss of a man in space cannot be concealed because thousands of people play a role in his flight and such information cannot but leak out. I could not but know about such a flight due to my direct service assignments. And on my oath I bear witness: the article by Bolonkin is a tissue of lies.

"Incidentally, just who is this Aleksandr Bolonkin? In the short introduction it is reported that he is a doctor of technical sciences who worked in our aviation and rocket industry for 30 years and now lives in New York. I was engaged in 'space' journalism for 30 years, I was at both Baykonur and Kapustin Yar, at many space scientific research institutes and design bureaus, but I never heard this name. In 1991 a book was published by Bolonkin in the United States entitled 'Development of Soviet Rocket Engines for Strategic Missiles.' The engines of strategic missiles were the product primarily of the special design bureau which was headed by the late Academician V. P. Glushko. I rang up his former deputy, V. I. Kurbatov, who worked for many a month at both Kapustin Yar and Baykonur, and who was thoroughly acquainted with all 'space' engine specialists."

"This is the first time I've ever heard this name," says Vladimir Ivanovich with surprise. "If a doctor of sciences has written such a book, I could not but know him..."

"It is a pitiful book," asserts M. V. Tarasenko of the Moscow Physical Technical Institute, an expert on Soviet cosmonautics. "I have just returned from the United States, where I lectured, and I saw this book. This is a rehash of articles from our encyclopedia 'Kosmonavtika' (Cosmonautics), published seven years ago..."

Still another of Glushko's former deputies, D. D. Sevruk, now a professor at the Moscow Aviation Institute, bears witness: "I venture to say that I know almost all the specialists who were associated with the engines of strategic missiles, but I do not know Aleksandr Bolonkin. In addition, in the late 1960's I was involved in problems related to the reliability of our rocket-space technology and analyzed and systematized all cases of failures. I had to weasel my way to unknown accidents which the responsible parties strove to conceal. But there can be no talk of human victims. I could not but know if there had been such cases."

We forgive A. Bolonkin that he did CIA a bad turn. It is necessary to attract attention to oneself, to pass oneself off as a leading specialist. New York is a frenzied town. You can create a sensation if you want to dish out stuff like this.

Scientific Results From 'Gamma' Astronomy Satellite

927Q0072A Moscow ZEMLYA I VSELENNAYA in Russian No 4, Jul-Aug 91 pp 28-33

[Article by A. M. Galper, doctor of physical and mathematical sciences, Moscow Engineering Physics Institute: "Space Experiment in the Field of Gamma Astronomy." The first paragraph is an introduction.]

[Text] Today not very much attention is being given to TASS communications on the launching of space vehicles. We are accustomed to them and the social problems with which our time is saturated have pushed these communications into the background. And therefore few took notice of the launching of the "Gamma" space observatory on 11 July 1990. Accordingly, our journal began in the preceding number, and in this issue we continue to familiarize the reader with the "Gamma" project.

Origin of Project Almost 20 years ago (in 1972) Academician V. l. Ginzburg presented a report at a session of the Presidium USSR Academy of Sciences in which the need was substantiated for developing research in the field of gamma astronomy. Even then it was decided to allocate sums for developing scientific equipment, but, to be sure, the matter of a space vehicle remained open. It can be said that planned work on implementation of programs for gamma astronomy observations began in our country from that time. The "Gamma" project, providing for research on "gamma stars" in the energy range 50-500 MeV, determination of their coordinates (localization), time and energy characteristics and study of the gamma radiation of the sun, Galaxy and extragalactic objects, became one of these programs.

It is well known that gamma astronomy is observation of the universe in the most "energetic" part of the spectrum of electromagnetic radiation (a wavelength of about 10^{-12} corresponds to a quantum energy of 0.1 MeV). Gamma radiation of such an energy arises as a result of bremsstrahlung and synchrotron radiation of electrons of a superhigh energy, de-excitation of excited nuclei, decay of neutral pions and other unstable elementary particles and annihilation of antimatter and matter (p, p, e^-, e^+) [Note: here p is overlined]. In other words, the gamma radiation arising during the interaction of high-energy cosmic particles with matter and antimatter carries information on many processes transpiring in the universe. Recently gamma astronomy, X-ray astronomy and the physics of cosmic rays have come to be called high-energy astrophysics. Only very energetic gamma quanta with an energy greater than 10^{12} eV create an electron-photon shower in the upper atmosphere whose "spray" reaches the Earth's surface. Accordingly, primary cosmic gamma radiation does not reach the Earth and its study requires use of high-altitude balloons and space vehicles (ZEMLYA I VSELENNAYA, No 1, 1973; Nos 3, 4, 1981). Much time has elapsed since beginning of implementation of the "Gamma" project. This also involved work in constructing, testing and calibrating of the telescope in an accelerator, search for a satellite and repeated postponements of the launching times (the first official time was 1982). At that time launchings of special space vehicles (SAS-2 and COS-B) with a gamma telescope aboard, operating in the same range as the "Gamma-1," took place in the United States and then in Western Europe. About 15 discrete sources were discovered, among which only four were reliably identified with known radio, optical or X-ray objects: two pulsars, hydrogen cloud and Seyfert galaxy. Data were obtained on radiation from the Milky Way and from regions situated in the higher galactic latitudes. These results are very important, although they may seem few in number. It must be remembered that the energy of an X-ray quantum is three orders of magnitude less than the energy of a γ-quantum, and this means that the fluxes of X-rays are five-six orders of magnitude greater than for γ-quanta. Accordingly, it is necessary to have gamma telescopes with a large aperture, high angular resolution and a great sensing area, and also prolonged, very prolonged continuous observations up to one, two months for the very same sector of the celestial sphere. With respect to all these parameters the "Gamma-1" gamma telescope and the "Gamma" observatory in which it was installed were better than the experiments on the SAS-2 and COS-B vehicles. And this meant that the "Gamma-1" telescope faced a good many problems prior to its launching in 1990.

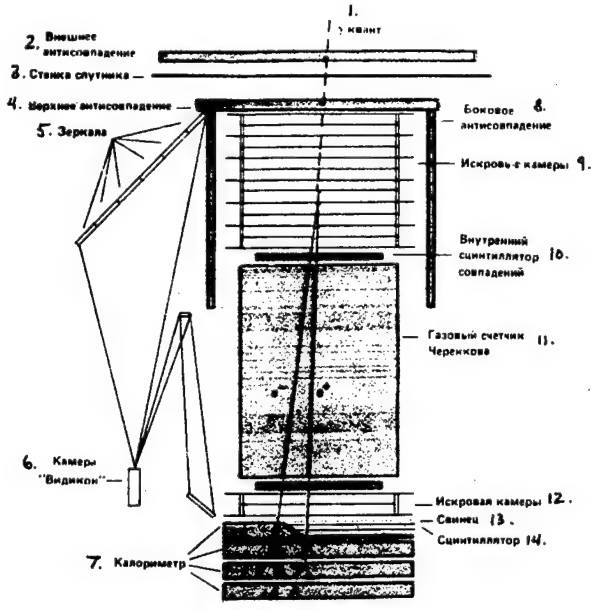
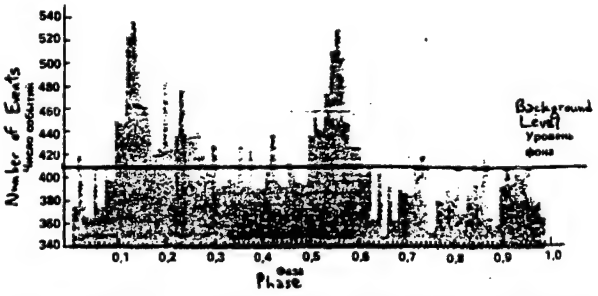


Diagram of structure and operating principle of "Gamma-1" telescope.

1) gamma quantum; 2) external anticoincidence; 3) wall of satellite; 4) upper anticoincidence; 5) mirrors; 6) Vidicon camera; 7) calorimeter; 8) lateral anticoincidence; 9) spark chambers; 10) internal coincidence scintillator; 11) Cerenkov gas counter; 12) spark chambers; 13) lead; 14) scintillator

"Gamma-1" Telescope

First we will become acquainted with the operating principle for the "Gamma-1" telescope. A gamma quantum passes through end-type scintillation counters without interaction and in one of the plates of the multilayer spark chamber is transformed (is converted) into an electron and a positron, which are registered as ordinary charged particles in scintillation counters and in a Cerenkov gas counter. In the calorimeter the particles form an electron-photon shower. If a random charged particle passes through the telescope, in contrast to a gamma quantum it also gives rise to signals in the end-type upper scintillation counters. The electronic circuit of the telescope analyzes combinations of the forming signals: if the signal in the counter above the Cerenkov detector outpaces the signal from the lower counter, a gamma quantum in actuality has entered the telescope from above (or an electron has passed through). Protons also can give rise to a signal in the Cerenkov counter, but for this alone their energy must be greater by a factor of almost 1000 than for electrons. The time of flight of particles with an accuracy to 10^{-3} s and their energies are determined in the stage of "sorting" of particles.

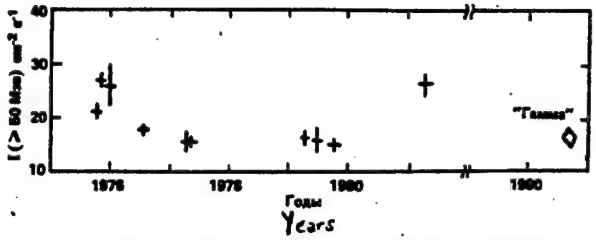


Phase curve of gamma radiation of pulsar in constellation Vela. The period (89 ms) is broken down into intervals (per 100 phases). Two principal peaks and the interimpulse radiation between them stand out clearly above the background level.

A second stage in the registry of particles is used for more precise determination of the "angle of arrival" of a gamma quantum. It involves the following. When the electronic system has recognized that a gamma quantum has entered the instrument a short high-voltage pulse (about 20 kV) is fed to the plates of the spark chambers. In the place where the electron and positron passed through the chamber a track of ionized neon atoms (the chambers are filled with them) remains from the converting gamma quantum and particle and a visible electric breakdown spark arises. The coordinates of the sparks are stored and transmitted to the Earth. Already in the final processing of the picture from the track of an electron and positron it is possible to retrieve the direction of motion of a gamma quantum with an accuracy to 2°. This stage in registry of a gamma quantum makes it possible to pinpoint the source of gamma radiation in the celestial sphere, discriminating it from the flux of background radiation.

Observation Program Under the flight program the first fourteen days were devoted to testing of the on-board systems. A team at the Flight Control Center learned to control the observatory and checked operational expenditures. In general the flight proceeded normally (the orbital altitude was approximately 420 km and the inclination was 51.6°).

Activation of the scientific instruments began in the third week. After a week plans called for proceeding to implementation of the program of astrophysical observations. However, it soon became clear that electric power was not flowing to the group of spark chambers. Was there a defect within the gamma telescope? Long and stubborn attempts to correct the situation were unsuccessful (ZEMLYA I VSELENNAYA, No 3, 1991)....

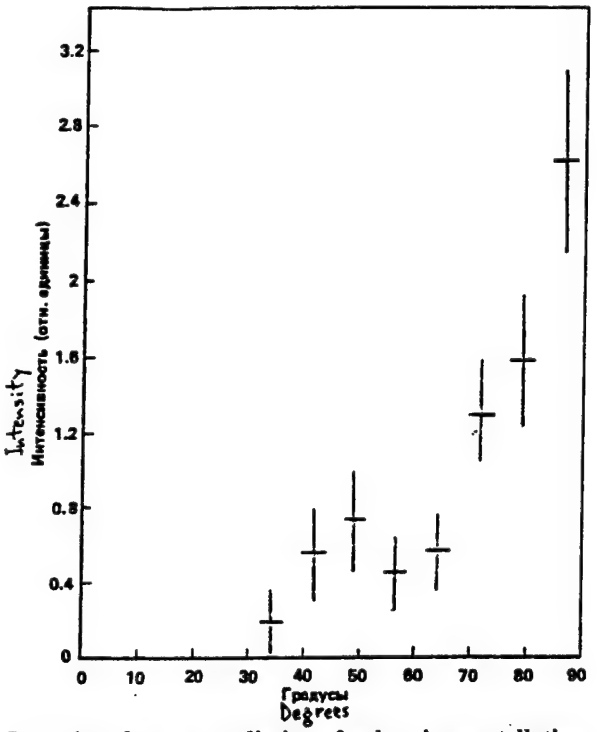


Angular distribution of electrons in Earth's radiation belt (region of Brazilian anomaly) and outside it. A considerable increase in the intensity of fluxes with an increase in pitch angle (the angle between the velocity of the particle and the direction of the magnetic field at the measurement point) was discovered. Particles having a pitch angle equal to or close to 90° are radiation belt particles.

The developing situation made it necessary to change the observation program, bringing to the forefront search for and investigation of variable sources of gamma radiation (pulsars, neutron stars, variable binaries of the type Cyg X-3, Her X-1). Observations of the active sun also are of interest because there is a probability of registering gamma radiation during the time of a strong solar flare. Finally, the "Gamma- 1" telescope can be used successfully in the registry of electrons and positrons in the energy range 20-5000 MeV.

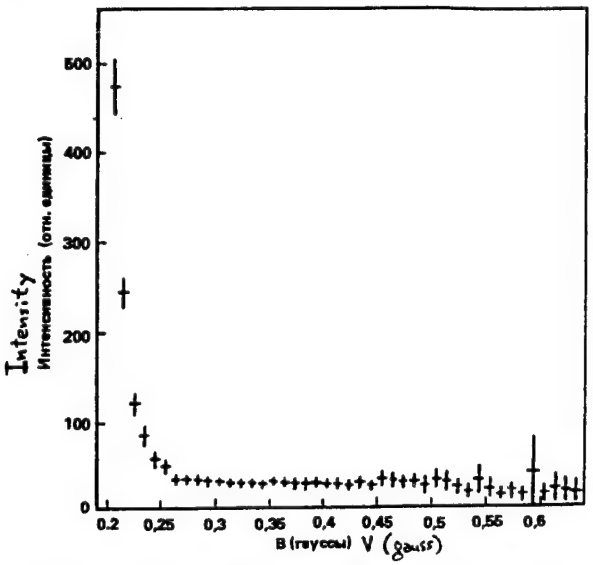
During the first six months of flight of the "Gamma-1" observatory observations were made of the following objects: Gamma pulsar in the constellation Vela (320 hours net time). Center of the Galaxy (30 hours). Binary system Cyg X-3 (200 hours). Binary system Her X-1 (310 hours) Heming gamma source in the constellation Tau (180 hours). The sun (several observation sessions, 100 hours). New X-ray source in constellation Mus (25 hours). Observations of the pulsar in Vela and Cyg X-3 were continued after February 1991. Both sources are

registered on the same revolution: when the pulsar is occulted by the Earth the "Gamma-1" telescope is directed to Cyg X-3. And so it goes, if everything proceeds normally, 16 times a day.



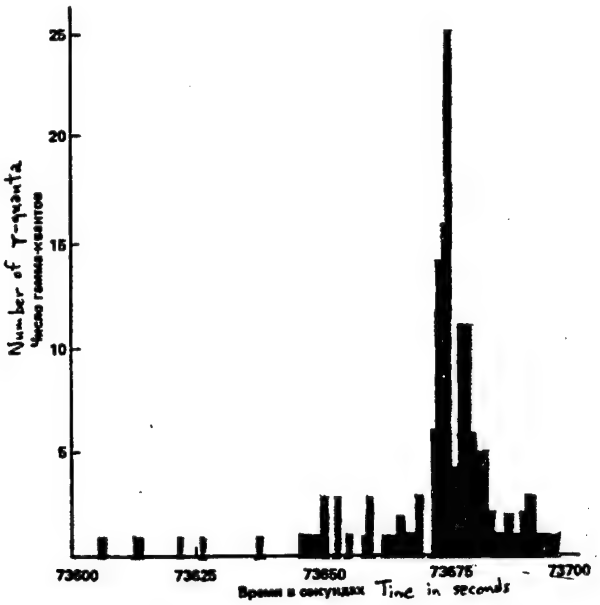
Intensity of gamma radiation of pulsar in constellation Vela during different years (using earlier data and new measurements in "Gamma" experiment).

Each day almost 30 million bits of information are transmitted to the Earth and arrive at the Flight Control Center, Energiya Scientific Production Association, Space Research Institute, USSR Academy of Sciences (and from there to France, Poland), Moscow Engineering Physics Institute, Physics Institute imeni P. N. Lebedev, USSR Academy of Sciences and Physical Technical Institute imeni A. F. Ioffe, USSR Academy of Sciences). Careful processing of the experimental material, analysis and interpretation of the results, are proceeding at all scientific centers participating in the joint experiment. First Scientific Results Only two pulsars—remnants of supernovae in Crab Nebula (PSR 0531+21) and in the constellation Vela (PSR 0833-45) also are gamma pulsars. The periods of rotation of these pulsars are 33 ms and 89 ms respectively. The pulsar in Vela became the first object observed with the "Gamma-1" telescope. Two factors were taken into account in beginning observation with this object. The first and most important was: the possibility of its use as a calibration source, also making it possible to develop a method for discriminating useful gamma quanta events from the known radiation period. Second: direct study of the gamma radiation flux nine years after the observations of 1981 (COS-B telescope). It is known that the variability of the source PSR 0833-45 is clearly expressed.



Dependence of intensity of electron flux on magnetic field strength (for inner part of Earth's radiation belt). With ascent along the magnetic line of force there is a decrease in magnetic field strength and with some value corresponding to the boundary of the radiation belt there is a sharp increase in the flux of high-energy electrons (this means that they are in the radiation belt).

A phase curve is constructed in order to discriminate the gamma radiation of a pulsar against the background of secondary gamma radiation and radiation from the Milky Way (the pulsar is situated in the galactic plane). For this purpose the entire observation time must be broken down into intervals and the commencements of all the intervals must be matched. In actuality, a difficult experimental problem arises whose solution requires a knowledge, with a very high accuracy, of the radiation period and the first and second derivatives of this period. The spatial position of the telescope must be well known at each moment of registry of a gamma quantum. The time of registry of an individual gamma quantum must be registered with an accuracy to 0.5 ms. The phase curve of the gamma radiation of the pulsar PSR 0833+45 consists of the first and second principal peaks (impulses) and interimpulse radiation (after the first peak). Such a picture, in general, coincides well with preceding measurements. But the intensity of radiation in the impulses and in the interimpulse period differs from the earlier measurements. The quantum energy in the impulses also differs somewhat. Precisely what results in changes in the intensity of pulsar radiation for the time being is not very well understood. But each new measurement will favor solution of this important problem.



Gamma burst on sun on 26 March 1991 (maximum at 23 hours 27 minutes 55 seconds Moscow time). Time in seconds (UT) is plotted along the x-axis from 0000 hours on 26 March 1991.

High-energy electrons and positrons. These particles with an energy greater than several tens of millions of electron-volts, registered in the Earth's neighborhood (at satellite altitudes), are generated by different sources. For example, they may be primary cosmic particles emanating from interstellar space. But they also may be generated by the sun during the time of powerful solar flares. They may arise as a result of interaction between cosmic protons and the upper atmosphere and then escape into circumterrestrial space. Finally, these may be particles accelerated in the radiation belt. Until recently it was assumed that in the inner part of the radiation belt, situated near the equator, electrons and positrons (henceforth we will call them electrons) may have an energy not greater than several million electron-volts. However, electrons up to several hundred million electron-volts have been registered. Accordingly, there are acceleration or other processes in the radiation belt responsible for these particles. What can the "Gamma-1" experiment clarify here? Literally several intersections of the radiation belt in the region of the Brazilian magnetic anomaly, where the belt "sags" to the orbit of the observatory, make it possible to obtain experimental data in a volume equal to that accumulated in all preceding experiments. Some preliminary results of measurements carried out with the "Gamma-1" telescope (angular distribution of electrons and the dependence of intensity on magnetic field strength) are shown in the graphs. The high statistical validity of the experimental data also makes it possible to study finer effects in the angular and energy distributions of electrons and positrons.

Gamma radiation from solar flare. Scarcely anyone doubts that on the sun there are acceleration processes giving rise to the appearance of high-energy protons and electrons. Some of the accelerated particles escape from the sun and are registered near the Earth and another part is returned to the sun where it interacts with the solar atmosphere and is manifested in flares in different ranges: from radio and optical to X- and gamma-radiations. When an active spot group appears on the sun, which is usually accompanied by a quite strong flare, there was interruption of planned observation of a definite sector of the celestial sphere and the "Gamma-1" telescope was oriented on the sun. There was a return to the usual observation program after three or four days, when the group passed beyond the limb. A hundred hours of solar observations were completed by a "happy case." On 26 March 1991, at 2325 hours Moscow time, the observatory emerged from the Earth's shadow and the next solar observation began, and already at 2327.5 hours the "Gamma-1" telescope registered an abrupt impulse of high-energy gamma radiation. Some time later this information was transmitted to the Earth. But only after two days, when it became known that on 26 March there had been a powerful solar flare, vigorous processing of the information file began. The duration of the flare was somewhat greater than ten seconds. The energy of the gamma quanta attained three hundred million electron-volts. It can be asserted that a flux of such high-energy particles was registered for the first time during the entire period of solar observations and evidently was associated with the decay of neutral pions. Both the intensity and temporal distribution and energy of the gamma quanta will have great importance for explaining the nature of the flare.

The flight of the "Gamma-1" observatory is continuing. Soon observations will begin on the American Gamma-Ray Observatory (GRO). We propose that observations be carried out under a coordinated program and we will report to the readers of ZEMLYA I VSELENNAYA concerning the most interesting new results.

Participant Recounts High-Priority Search for Sunken Satellite

927Q0085A Moscow OGONEK in Russian
No 46, Nov 91 p 6

[Article by V. Nikitenko, former senior diving specialist of search team: "Operation 'Lawn'"]

[Text] I was silent for a long time and most likely would have carried to the grave the secret of this operation, but after the Chernobyl nuclear power plant catastrophe I was impelled to make it public.

In 1968 I served in the Red Banner Black Sea Fleet as a leader of a team of divers of an experimental submarine. On 6 September I was called to the fleet headquarters.

There I received an order to depart for Balakovo in order to perform a government mission of special importance.

On 7 September I arrived at the ship and we departed in order to proceed by plan. Aboard there were eight divers who were commanded by chief petty officer S. K. Palamarchuk, later awarded an order for clearing mines from Vietnamese ports. The diving team had in-depth experience in search for and disarming of explosives, was indoctrinated to work in pitch darkness and could find a needle in a haystack at any depth.

In the canal locks we met with civilian ships of the "river-sea" type. The sailors asked us: were we going to seek the atomic bomb which fell in March in the Saratov Reservoir? They learned this fact from the "grapevine."

We arrived simultaneously with another ship which carried nine highly trained divers headed by the warrant officer A. V. Nikulin.

I was introduced to the detachment commander, Subcommander Ye. Gerasimov, and received the order to seek for a space object. The commander, like his predecessors, did not communicate what this object was. The representative of the Air Force Volga Military District, Lt. Col. I. Kapustyan, answered me: "Look around and report back on whatever you encounter and we will figure it out."

On 17 September we undertook a search for the object without having the slightest notion of what we were looking for. I learned from the local inhabitants that in March a sphere descended by parachute over Balakovo and was accompanied by a helicopter. The wind which arose carried the sphere into Saratov Reservoir. When the sphere (we will call it a satellite) landed in the water a buoy with a line was separated from it. The line had a length of 50 m and a circumference of 11 mm (this is what I. Kapustyan said). The helicopter gave a command to a passing dry cargo ship to raise the buoy aboard. The ship came to a standstill, without casting anchor. The seamen read on the buoy the inscription; "Radioactive! Do not touch with the hands!" Then they tied the line securely around the desk posts and the ship, without anchor, drifted with the current. As a result, the line broke, a wave swept over the shaft where a parachute with a total area of 500 square meters lay and the satellite sank.

This was reported to the Minister of Defense Marshal A. A. Grechko, who gave the order: "Find it and get it." The finding and return task was delegated to the navy. Orders were given to dispatch two mine sweepers and to drag for the satellite. The mine sweepers dragged the entire reservoir, but unsuccessfully. And only after the failure which had taken place was it decided to use divers. And it was necessary to begin this work. The work plan was approved by Air Force Lt. General K. Tsedrik, commander of the Volga Military District.

What is the bottom of Saratov Reservoir like? The main navigation channel is for the most part clear and the bottom is hard clay. Beneath the water there are trees (forest), willow undergrowth, destroyed structures, wells, etc. The depth is from 7 to 32 m and the current is 3-4 km/hour. The reservoir is 4 km wide in the sector where the satellite fell. There is zero visibility beneath the water. Need it be said how difficult it was to work?

The area was explored by squares. But, I repeat that we did not know what we were looking for. And then I found a metallic object somewhat resembling a sunken buoy. The Air Force bosses, General Tsedrik, 11 colonels and one civilian comrade arrived on a high-speed mine sweeper. Then I learned that the civilian was Secretary of the CPSU Central Committee for Space Research. I reported to the civilian. It was found that the object was not what we were looking for. Becoming bold, I declared that specific information was needed, otherwise we could not find the object. The man in civilian garb allowed General Tsedrik to inform us. I still retain the picture in my mind. We had assumed that we were seeking a metal object, but it was found that the satellite was covered by a ceramic covering. Mounted on the cover was a detonator with an explosive charge of 350 kg. If the buoy had the inscription "Radioactive," the entire satellite should emit radiation. I proposed use of radiation monitoring instruments. The proposal was not adopted. The civilian comrade emphasized the special importance of the task and promised big rewards in the event of success. I did not think that he was talking through his hat.

Working up to 31 October, on the bottom we found just about everything except a satellite. This was the sole failure in my long diving career. I had retrieved artillery shells, mines, torpedoes, aircraft, and suddenly no luck. Carefully analyzing the failure, I concluded that probably the dry cargo ship, getting under way when the line snapped, snagged the parachute with its the rudder blade and the satellite was dragged upcurrent. Then the parachute somewhere was torn away. We found the rudder blade. But possibly the mine sweepers dragged the parachute into a well and it got covered over. However, this is improbable because, after all, its area was 500 square meters.

I know that the search for the satellite was not renewed during these 25 years. If a misfortune occurred, there is no one to ask about it from this remoteness of time. There has been a change in governments and General Secretaries and ministers of the military departments have operated on the principle: after me—the Deluge.

Silence was long maintained concerning the nuclear explosion at Kyshtym in 1957. Nothing was said about the consequences of the explosion on a ship in the coastal port of Shkotovo. There is no need to fear that a panic will set in. I feel that it is better to know the truth than to live in fear. Participants in the operation are alive and I have kept the maps. To be sure, in telling about this I risk being hauled into court for divulging the secret of operation "Gazon," but I cannot be silent about it.

What to do now? Begin a new search? I don't know. Possibly a convincingly qualified answer of specialists will be adequate for proof that no explosive device is hidden at the bottom of Saratov Reservoir.

Lunar Petrology

927Q0086A Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA: GEOLOGIYA in Russian No 6, Nov-Dec 91 (manuscript received 28 Mar 91) pp 3-22

[Article by A. A. Marakushev, Moscow University; UDC 552.11:551.24:551.71]

[Abstract] Data are generalized for lunar rocks and their principal petrochemical types, represented by completely vitrified varieties and others crystallized to different degrees but which are similar in composition. The similarity between the Moon-Earth system and the Io-iron-stone core of Jupiter system is stressed. Evidence is outlined that the Earth and Moon were formed simultaneously in the course of development of a common mother planet, similar to Jupiter or Saturn, having a thick hydrogen envelope which later migrated as a result of surface degassing under the influence of a young sun. In this process the Earth lost a great many distant satellites similar to the Moon and the closest of these were destroyed and formed rings of fragmented material. The fragmented material fell onto the Earth in the form of planetocentric meteorites giving rise to the so-called "lunar" achondrites found in Antarctica. The article title "Lunar Petrology" emphasizes the focus of its content, but the materials, hypotheses and conclusions presented are much more far-reaching. This is reflected by the figures accompanying the text and serving as a basis for the presentation:

1. Characteristics of meteorites, lunar and terrestrial rocks;

2. Petrochemical diagram of lunar rocks;

3. Comparison of variation diagrams of pyroxenes in lunar rocks;

4. Variation diagrams of pyroxenes from plagioclase-pyroxene achondrites;

5. Stratification of minor planet in asteroid belt;

6. Dependence of depth of craters on moon on their diameters;

7. Petrochemical diagram of lunar glasses;

8. Petrochemical diagram of lunar crystalline rocks;

9. Correlation between massive satellites and their distance from Jupiter and Saturn.

10. Two-layer model of structure of Uranus;

11. Systems of rings and satellites of Uranus.

Figures 11; references 26: 13 Russian, 13 Western.

Observations of Nova in Musca Constellation With the SIGMA Telescope of the Granat Observatory: Hard X-Ray Spectral Properties and Discovery of Annihilation Line in the Spectrum

927Q0087A Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 17 No 12, Dec 91 (manuscript received 2 Sep 91) pp 1059-1081

[Article by M. Gilfanov, R. Sunyayev, Ye. Churazov, M. Pavlinskiy, S. Grebenev, R. Kremnev, K. Sukhanov, N. Suleshova, A. Goldwurm, J. Ballet, B. Cordier, J. Paul, M. Denis, L. Bouchet, D. Barret, and J.-P. Roques, Space Research Institute, USSR Academy of Sciences, Moscow; NPO imeni Lavochkin, Moscow; Astrophysical Service of the Center for Nuclear Research, Sacle, France; Center for Study of Cosmic Radiation, Toulouse, France; UDC 520.6;524.337]

[Abstract] The x-ray source GRS1124-684 was observed 11 times between January and August 1991 with the Granat observatory's ART-P and SIGMA coded-mask telescopes, which produced spectral data for the source in the energy range of 3-1300 keV. Although the luminosity in the hard x-ray range varied by more than an order of magnitude over the observation period, the overall slope of the spectrum in that range changed little. The variability of hard x-ray flux covered several hours, which points to instability of the accretion process in the inner part of the disk. The instability, however, is unexpectedly slow by comparison with typical times for the inner region of an accretion disk. The stability associated with the flux at energies below 6-8 keV indicate that the soft component is generated in the geometrically isolated region of the disk. A relatively narrow variable emission line was detected on January 20-21, 1991, near 500 keV, with a flux of around 7×10^{-3} phot/sec/cm^2, most likely associated with electron-positron pair annihilation. Figures 9, 44 references: 8 Russian, 36 Western.

Study of the Flight Trajectories to Halo Orbit in the Vicinity of the L_2 Libration Point of the Earth-Sun System With Use of Lunar Gravity

927Q0087B Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 17 No 12, Dec 91 (manuscript received 26 Aug 91) pp 1124-1134

[Article by M. L. Lidov, V. A. Lyakhova, and N. M. Teslenko, Institute of Applied Mathematics, USSR Academy of Sciences, Moscow; UDC 523.2]

[Abstract] A mission profile proposed by R. W. Farquhar for placing the Relikt-2 spacecraft into a trajectory that will take it to the L_2libration point some 1.5×10^6 km from Earth is studied. The spacecraft makes two revolutions in a highly elliptical orbit, with the transfer to the

Moon and on to the libration point effected in four segments: (1) a geocentric transfer leg from Earth to the environs of the Moon; (2) a selenocentric leg tht approximates a segment of a hyperbola; (3) a second geocentric elliptical (or hyperbolic) leg whose parameters are determined by geocentric coordinates and spacecraft velocity vector components upon exit halo orbit. The optimum times for the trajectory are chosen—January and October/November 1994. Numerical integration is used to calculate precise parameters. Figures 1, references 4: 3 Russian, 1 Western.

Strong Absorption Lines in Spectrum of Supernova 1987A During First Months After Explosion: Variations in Lines of Heavy Elements

927QOO88A Moscow ASTRONOMICHESKIY ZHURNAL in Russian Vol 68 No 6, Nov-Dec 91 (manuscript received 7 Aug 90) pp 1261-1273

[Article by L. S. Lyubimkov, Crimean Astrophysical Observatory, USSR Academy of Sciences; UDC 524.352]

[Abstract] Variations in the equivalent widths W_λ and depths d_λ of the absorption lines Ti II, Fe II, Ba II and Na I during the first months after the flare of the supernova 1987A were analyzed. It is demonstrated that a decrease in the temperature of the envelope in a definite stage was evidently replaced by its increase, this resulting in a sharp change in the shape of the W_λ and d_λ curves. Rough estimates show that the observed weakening of the Ba II λ 6142 line and the approximate constancy of the Fe II λ 5169 line in the interval t = 25-120 may be attributable to a temperature increase by 1500 K; the simultaneous enhancement of the Ti II lines in the UV region for its explanation requires an increase in the Ti abundance by tens of times. The warming was propagated in the envelope at a velocity v about 8000 km/s and began at the photosphere level in the period t = 10-20^d. It also is shown that during this same period t and with the same v values anomalies appeared in the behavior of the radial velocities measured using the Balmer lines. This article is essentially a continuation of an earlier study of SN 1987A by the author in this same journal (Vol 68, p 969, 1991) in which research was concentrated on Balmer line variations. Figures 6; references 21: 3 Russian, 18 Western.

Observations With Glazar Space Telescope in Regions of Cassiopeia, Gemini, and Monoceros

927Q0089 Moscow ASTRONOMICHESKIY ZHURNAL in Russian Vol 68 No 5, Sep-Oct 91 (manuscript received 6 Sep 90) pp 942-958

[Article by G. M. Tovmasyan, R. Kh. Oganesyan, R. A. Yepremyan, D. Huguenin, A. S. Viktorenko, and A. A. Serebrov, Byurakan Astrophysical Observatory, Armenian Academy of Sciences; Geneva Observatory, Switzerland; Cosmonaut Training Center, Zvezdnyy; UDC 52.774]

[Abstract] The Mir-based UV Glazar telescope, in manual mode, was used to observe star associations Cas OB1 (19 Sep 88), Cas OB2 (5 Jan 89), Gem OB1 (10 Feb 89), and Mon OB1 and Mon OB2 (15 Feb 89). The direction of the telescope was stabilized by controlling the attitude of the Mir station. At λ 1640 angstrom, seven early stars brighter than 9^m were found in the Cas OB1 field; 11 in Cas OB2; 13 in Gem OB1; and 35 in Mon OB1 and Mon OB1. Five of the stars observed are hot components of stars of later spectral types A0-F4. The spectra of 11 stars, as well as their stellar magnitudes at visible wavelengths, could not be determined. Of the seven stars in the direction of Cas OB1, four stars appear to be part of a group of stars about 400 parsec away. Five of the 11 stars toward Cas OB2 are probably members of the same group of late B subtypes. The distance between the two groups is about 60 parsec. Particulate matter makes absorption at 1640 angstrom on the order of 3^m.0. Four of the stars are an average of 700 parsec away and appear to be part of a new OB star association. Six of the stars found in Gemini are members of the Gem OB1 association. Absorption in that group reaches 5^m.2. The other five stars, primarily B8 types, are part of a group about 300 parsec away. Absorption is 1^m.0 in that group. Distance could be determined for only 16 of the 35 stars found in Monoceros. Five of the stars are part of Mon OB2 and are on its periphery. At 1640 angstrom, absorption is around 3^m. Five other stars are part of Mon OB1, and absorption reaches 2^m.5 near certain of them. A relatively dense circumstellar dust shell surrounds stars HD 5233 and 261 490. Figures 4, references 23: 4 Russian, 19 Western.

Influence of Relativistic Effects on Results of Satellite Geodynamics, Geodesy, and Navigation. Research Results

927Q0089B Moscow ASTRONOMICHESKIY ZHURNAL in Russian Vol 68 No 5, Sep-Oct 91 (manuscript received 17 Jul 90) pp 1093-1098

[Article by N. V. Yemelyanov and A. V. Krivov, State Astronomy Institute imeni Shternberg, Leningrad State University; UDC 521.176]

[Abstract] In the first half of the work reported here (see ASTRONOMICHESKIY ZHURNAL, 1991, Vol 68, p 872), the researchers described a technique for studying relativistic effects that uses a physical model and a set of computer programs to perform the research. This paper presents the results of the research, which involves various problems associated with the motion of three types of satellite—low-altitude, mid-altitude (LAGEOS), and high-altitude (synchronous). The relativistic effects involve station coordinates, time, light propagation, and disturbances. The researchers conclude that disregard of the relativistic effects in algorithms for refining parameters can lead to problems of a varying nature. In some cases, residual error grows, as does rms error of refined parameters, usually when the number of refined parameters of the nonrelativistic model are comparatively small. In other cases, the sought-for parameters vary

widely from true values. Solution of actual geodynamic, geodesic, and navigation problems with a satellite is usually done in several stages. Disregard of the relativistic effects can lead to appreciable worsening of intermediate results, but the errors in some cases are compensated for and lower accuracy in the final results only slightly. References 2 (Russian).

Motion of Satellite With Flexible Viscoelastic Rods in Noncentral Gravity Field

927Q0091A Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 29 No 6, Nov-Dec 91 (manuscript received 10 Dec 90) pp 815-821

[Article by A. V. Shatina; UDC 629.78]

[Abstract] The following problem is considered. A satellite, constituting a circular plane disk, along whose symmetry axis there are two viscoelastic rods, and along whose other axis, perpendicular to the first, there are two rigid rods of the same length, moves in the noncentral gravity field of an asymmetric planet in its equatorial plane. A coordinate system OXYZ is rigidly coupled to the planet; its axes are the principal central axes of inertia of this planet, which rotates at a constant angular velocity about the OZ axis. Satellite motion is in the plane OXY. A coordinate system $Cx_1x_2x_3$ is rigidly coupled to the disk. The point C is satellite center of mass in a position when the viscoelastic rods are linear and oriented along the Cx_1 axis; the rigid rods are oriented along the Cx_2 axis. Using the linear theory of flexure of thin inextensible rods, it is possible to determine the radius vector of a rod point in the $Cx_1x_2x_3$ coordinate system. In this formulation, by averaging in Delaunay canonical variables, approximate equations are derived for describing the motion of such a satellite. References: 4 Russian.

Satellite Motions Asymptotic to Its Regular Precessions

927Q0091B Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 29 No 6, Nov-Dec 91 (manuscript received 13 Feb 91) pp 822-827

[Article by B. S. Bardin; UDC 521.13]

[Abstract] The following problem was examined. It is assumed that the center of mass of a dynamically symmetric satellite moves in a central Newtonian gravity field in a circular orbit. The following coordinate system was introduced for describing satellite motion relative to the center of mass: an orbital coordinate system OXYZ, whose axes are directed along the velocity vector of the center of mass (OX), along the normal to the orbital plane (OY) and along the radius vector of the center of mass (OZ); Oxyz is a system rigidly coupled to the satellite, the Oz axis coinciding with the axis of dynamic symmetry of the satellite. The origin of coordinates in both systems relative to the orbital system is determined using the three Euler angles. In this formulation solutions of an autonomous Hamiltonian system with two degrees of freedom with second-order resonance, asymptotic to a position of equilibrium, are investigated by methods described by A. P. Markeyev, et al. (IZV. AN SSSR. MTT, No 4, pp 3-10, 1987; PMM, Vol 51, No 3, pp 355-362, 1987; Vol 54, No 2, pp 207-212, 1990). The necessary and adequate conditions for existence and an analytic representation of the asymptotic solutions were found. The results are used in the problem of motions of a dynamically symmetric satellite asymptotic to its regular precessions in a circular orbit. References: 15 Russian.

Stabilization of Satellite With Flexible Rods. II

927Q0091C Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 29 No 6, Nov-Dec 91 (manuscript received 2 Nov 90) pp 828-839

[Article by S. I. Zlochevskiy and Ye. P. Kubyshkin; UDC 629.78]

[Abstract] In an earlier study (KOSMICH. ISSLED., Vol 27, No 5, p 643, 1989) the authors investigated the problem of stabilization of the angular position of a satellite having two flexible linear rods and a jet stabilization system. It was assumed that the central part of the satellite was a solid body and that the identical rods with rigid attachment of one end and a free second end were elastic. Small satellite oscillations were taken into account. The effects of external forces and moments on the satellite were neglected. In the case of small satellite oscillations antisymmetric transverse elastic oscillations of the rods in the orbital plane were taken into account. The material of the flexible rods was considered viscoelastic. In this second part of the study, making constant reference to the first part, use is made of the same notations, boundary and initial conditions. Two models of a viscoelastic body are examined in detail. The first is a Focht model and the second is a linear model of hereditary viscoelasticity. The regions of stability of the stabilization system are investigated in the space of feedback coefficients. Specific examples are given as illustrations. Figures 2; references: 5 Russian.

System for Orientation of Deformable Space Vehicle With Nonlinear Correcting Device

927Q0091D Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 29 No 6, Nov-Dec 91 pp 840-848

[Article by G. Ya. Ledenev; UDC 531.381]

[Abstract] The adequate conditions for stable control are found for the orientation of a deformable spacecraft with a nonlinear correcting device, making it possible to determine the parameters of the correcting device and key parameters for the control system. In the considered dynamic system the satisfaction of the stability conditions at the minimum or critical frequency of elastic

oscillations also ensures their satisfaction at other frequencies. Attainment of stable control does not require full a priori information concerning the frequency spectrum of elastic oscillations. The structure of the correcting device makes it possible to organize control in the form of a relay function of its output signal, the controlling signal at whose input is a linear combination of spacecraft angular deviation and angular velocity signals, making the control algorithm particularly simple. The described orientation system, in comparison with a system not containing a nonlinear correcting device, retains stability with considerably greater amplitudes of the angular velocity of elastic oscillations, which considerably broadens the region of stability of the spacecraft orientation system. Figures 2; references: 7 Russian.

Reorientation of Dynamic Symmetry Axis of Rotating Spacecraft

927Q0091E Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 29 No 6, Nov-Dec 91 (manuscript received 14 Nov 89) pp 849-857

[Article by L. D. Akulenko and N. V. Nikolayev; UDC 629.197.23]

[Abstract] A time-optimum reorientation of the axis of dynamic symmetry of a spacecraft with a simultaneous stipulated change in the angular velocity of twisting was examined in a book by L. D. Akulenko (Asimptoticheskiye Metody Optimalnogo Upravleniya [Asymptotic Optimum Control Methods], Moscow, Nauka, 1987) in which a quasioptimum solution was obtained providing for the sought-for successive reorientation of the spacecraft symmetry axis with a constant angular twist velocity and with a subsequent fixed change of the latter. In this article the problem is examined in a similar formulation for a case when the components of the controlling moment of forces are limited to a cylindrical region. Algorithms are written for obtaining a full solution of the problem. The solution is compared with that obtained in the earlier mentioned source in which similar notations and conditions were used. The derivation of the equations of motion is given, together with a formulation of the optimum control problem, an optimum solution is found and analyzed and algorithms for numerical solution of the problem are outlined. Figures 5; references: 6 Russian.

Spatial Rotations of Satellite in Circular Three-Body Problem With Fractional Resonances

927Q0091F Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 29 No 6, Nov-Dec 91 (manuscript received 24 Oct 89) pp 858-871

[Article by P. S. Krasilnikov; UDC 531.36]

[Abstract] A study was made of the spatial rotations of a satellite relative to the center of mass in a circular three-body problem with fractional resonances $O = \omega_0/2$, $O = 2\omega_0$, where O is the angular velocity of unperturbed satellite rotation, ω_0 is the mean motion of finite masses. The satellite is considered to be a body with a negligible mass. It is assumed that the trajectory of motion of the center of mass of the solid body is described by conditionally periodic functions of time and its central ellipsoid of inertia is close to a sphere. It is shown that the averaged equations of rotation of an asymmetric satellite allow a family of integral manifolds in which solution of the problem is reduced to quadratures. The satellite rotations in these manifolds are described. The motions of such an axisymmetric body are investigated and a geometric interpretation of resonance satellite rotations is presented. Several special cases are examined. This is essentially a continuation of an earlier article by the author (KOSMICH. ISSLED., Vol 28, No 6, 1990) which dealt with nonresonance motions and also plane resonance rotations of a symmetric satellite. Figures 5; references: 6 Russian.

Approximate Computation of Maneuvers for Forming Earth Satellite Orbit Using Low-Thrust Engine

927Q0091G Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 29 No 6, Nov-Dec 91 (manuscript received 15 Sep 88, after revision 16 May 90) pp 872-888

[Article by V. V. Salmin and V. O. Sokolov; UDC 629.78]

[Abstract] The planning of computations of the trajectories of earth satellite orbits should be adequately simple, graphic and insofar as possible be represented in analytical form. Although various approaches for solving this problem have been proposed, a study was made to find laws for control of the orbital elements of an earth satellite with a low-thrust engine in a noncentral gravity field which are superior to those previously published. The overall problem is divided into a series of special problems for control of groups of phase variables. The optimum structure for control within the limits of a defined revolution is established. Approximate analytic solutions are obtained for problems involved in control of orbital evolution. Analytic expressions are derived for computing the expenditures of characteristic velocity on change of satellite orbit and its spatial position and on reduction of the space vehicle to a stipulated point in orbit. Estimates are made of the methodological error of the approximate solutions based on numerical simulation of motion and the dependence of maneuver energy on reactive acceleration is determined. Figures 5; references 8: 7 Russian, 1 Western.

Construction and Choice of Trajectories for Passive Flyby of Groups of Celestial Bodies Moving in Keplerian Orbits

927Q0091H Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 29 No 6, Nov-Dec 91 (manuscript received 5 Feb 90) pp 889-904

[Article by M. Yu. Akhlebininskiy and M. S. Konstantinov; UDC 629.785]

[Abstract] The problem of constructing the orbits of a vehicle for a flyby of several designated celestial bodies moving in Keplerian orbits is solved in a new formulation. The existence of orbits allowing a single vehicle to fly by at least three bodies is established. The theorem of the existence of an orbit for the flyby of three bodies moving in circular orbits of the same radius is formulated and demonstrated. The problem of the uniqueness of such orbits is analyzed. An effective numerical method for constructing the orbits for the flyby of three bodies moving in arbitrary elliptical orbits is proposed. The procedures used in determining the accuracy in computing passive flyby orbits are outlined. The appropriate system of equations for this purpose is given; solution of the pertinent Lambert and Kepler equations also is required. The possibilities of the method are illustrated in examples. A table gives the results of computer simulation of orbits for the flyby of three asteroids. Another table lists the parameters of orbits for flyby of other groups of three asteroids. The determined orbits constitute a first quite good approximation for computing real trajectories. Figures 4; references 6: 5 Russian, 1 Western.

Parameters of Angular Distributions of Trapped Protons in Brazilian Magnetic Anomaly

927Q0091I Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 29 No 6, Nov-Dec 91 (manuscript received 24 Sep 90) pp 905-909

[Article by V. V. Bengin, V. M. Petrov, V. A. Shurshakov and I. A. Muratova; UDC 523.037:525.7]

[Abstract] On the basis of available data on proton fluxes in the Brazilian Magnetic Anomaly quantitative estimates were made for parameters characterizing the distributions of proton fluxes by local pitch angle and phase angle of Larmor rotation in years of the solar activity maximum and minimum. There is evidence of a well-expressed anisotropy of the radiation field. A new formula ((2) in the text) is proposed for the pitch angle dependence. A table gives the parameters of the approximation of proton pitch angle dependence for the phases of the maximum and minimum of solar activity, L = 1.2-2.0 and E_p = 20-200 MeV. It is desirable that the results of such research on the anisotropy of proton fluxes be used in computations of radiation loads for objects with a known orientation when they intersect the Brazilian Magnetic Anomaly and also in the interpretation of measurements of proton fluxes or absorbed doses made in the Brazilian Magnetic Anomaly by directional detectors or global detectors behind anisotropic shielding. The results give evidence of the possibility of reducing by several times the level of radiation impacts on crew members of manned spacecraft in the anomaly zone, including during emergence into open space. Figure 1; references 18: 13 Russian, 5 Western.

Scintillation Gamma Spectrometer for Determining Composition of Martian Rocks From 'Fobos' Spacecraft

927Q0091J Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 29 No 6, Nov-Dec 91 (manuscript received 19 Jun 90) pp 933-943

[Article by Yu. A. Surkov, L. P. Moskaleva, A. G. Mityugov, V. P. Kharyukova, S. Ye. Zaytseva, G. G. Smirnov, O. P. Shcheglov, V. L. Gimadov, V. N. Rasputnyy, L. N. Myasnikova and S. S. Bulychev; UDC 523.031:523.44]

[Abstract] The scientific instrumentation carried aboard the "Fobos" spacecraft included a highly efficient, compact, low-weight scintillation gamma spectrometer intended for determining the elemental composition of Martian rocks. The 512-channel instrument operates in the energy range 0.3-10 MeV; power consumption is 13 W and weight is 12.5 kg. During the time of spacecraft operation 10 background spectra were measured on the Earth-Mars flight trajectory and 90 spectra of Martian rocks were registered in the planetary equatorial region in a zone about 1000 km wide. The gamma spectrometer consists of a detection module based on a CsI(Tl) crystal measuring 100 x 100 mm, pulse height analyzer and module for the registry of γ bursts and hard radiation of solar flares. Figure 1 is a block diagram of the spectrometer; Fig. 2 is a cyclogram of instrument operation; Fig. 3 is a block diagram of the detection module; Fig. 4 is a logic diagram of the pulse height analyzer. These figures serve as a basis for description of instrument structure and operation. The most important technical specifications are given. A series of preflight instrument tests, carried out during preparation for the "Fobos-2" experiment, is described. Figures 5; references 5: 4 Russian, 1 Western.

Biennial Variations in Manifestations of Solar Activity and Cosmic Rays

927Q0091K Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 29 No 6, Nov-Dec 91 (manuscript received 3 Jul 91) pp 947-949

[Article by V. P. Okhlopkov; UDC 612.014]

[Abstract] The dynamics of biennial variations in cosmic rays, geomagnetic and solar activity was compared and the phase relations among them were ascertained. There is a difference in the temporal variation in amplitudes of the biennial variation. A biennial wave is manifested in all the represented parameters, but it was expressed most clearly in galactic cosmic rays during the period 1966-1975 and then in 1980-1985, in geomagnetic activity during the same periods as in cosmic rays and in solar activity during the period 1968-1975. There was a distinct biennial variation in the neutrino flux in 1975-1980, the maximum manifestation of which occurred in the period of a decrease in the intensity of cosmic rays, solar and geomagnetic activity. The dynamics of the biennial variation reveals that in cosmic rays there is a

change in the period of its variation: whereas in 1967-1973 the variation period was 24 months, in 1974-1985 it was 20 months. The period changed similarly in the geomagnetic activity indices, but in the solar indices the variation period did not change and remained about 24 months. An analysis of the phase relations shows that there is a good correspondence between the biennial variations in cosmic rays and geomagnetic activity. The maxima of the biennial waves in cosmic rays lag behind the minima of the waves in the A_p index by one-two months. Taking into account that the A_p index exhibits the best correspondence with biennial cosmic ray variations and that the A_p index reacts to solar activity manifestations after four-five days, the A_p index can be regarded as a solar plasma activity characteristic. This activity, being a source of cosmic ray modulation, also determines the biennial variation of cosmic rays. The amplitudes of the biennial variations of the indices of solar and geomagnetic activity and the intensity of cosmic rays vary in a wide range and are modulated with a period nine-12 years. Figure 1; references 10: 8 Russian, 2 Western.

Optically Resolved Emissions Generated in Atmosphere Under Influence of Pulsed UV Radiation Source

927Q0091L Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 29 No 6, Nov-Dec 91 (manuscript received 17 Apr 91) pp 950-951

[Article by N. V. Yeliseyev, V. A. Kiselev and S. I. Kozlov; UDC 551.510.536]

[Abstract] The impact of a pulsed source of UV radiation on the upper atmosphere should result in the appearance of optical emissions of components of the disturbed region created by UV quanta. The authors, in a series of earlier studies, investigated the emissions of metastable components observed in a time interval exceeding the operating time of the source. Using the example of the emission spectrum of the first negative (1N) system of the N_2^+ bands and the second positive (2P) system of the N_2 bands, a study was made of optically resolved emissions whose radiation lifetimes are much less than the operating time of the UV radiation source. During the effective time of a pulse of UV radiation the main excitation mechanism of the first negative system of N_2^+ bands is photoionization, whereas for the second positive system of N_2 bands it is excitation by photoelectrons. However, there are no experimental data on emission in the mentioned systems of bands excited under the influence of sources of UV radiation. However, under the influence of a pulsed source of UV radiation there is excitation of the same systems of bands as for an X-radiation source. The absolute quantities of radiated energy differ by two-four orders of magnitude, which is attributable to differences in the parameters of the sources and also the specifics of observation geometry and computations. In addition, for the UV source the ratio of radiation energy in the 1N bands of the N_2 system to the energy in the 2P bands of the N_2^+ system is appreciably greater than that for X-radiation. This is attributable to the fact that the contribution of photoionization with 1N excitation of the N_2 system increases with an increase in wavelength of the ionizing radiation. Figure 1; references 6: 5 Russian, 1 Western.

Charge-Coupled Detector (CCD) Camera for Astronomical Observations

927Q0108A Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 17 No 10, Oct 91 (manuscript received 5 May 91) pp 953-960

[Article by V. Yu. Berezin, A. G. Zuyev, G. V. Kiryan, M. I. Rybakov, A. T. Khvilivitskiy, I. V. Ilin, P. P. Petrov, I. S. Savanov and A. G. Shcherbakov, Crimean Astrophysical Observatory, USSR Academy of Sciences, Nauchnyy village; UDC 520.2]

[Abstract] A new Soviet-produced CCD camera system is described. A block diagram of the system is given and the technical specifications are listed. The CCD camera has a matrix photomultiplier (virtual phase, n-channel type) with a number of elements 580 (v) x 520 (h), each element measuring (in μm) 24 (v) x 18 (h), with a spectral sensitivity range 3500-11000 A. The cryostat operates in the temperature range 120-210 K with a flow of liquid nitrogen 0.2 liter/hour, has a quartz entrance window, measures 220 mm in diameter and is 300 mm long and weighs 7 kg. The Soviet-produced CCD system, developed by the "Foton" Scientific and Technical Cooperative and tested using the telescopes at the Crimean Astrophysical Observatory, with respect to its principal characteristics is in no way inferior to foreign equivalents. Spectral observations of stars made using the ZTSh telescope with both the Soviet instrument and the foreign CCD-2000 camera under identical conditions revealed that with respect to sensitivity the Soviet CCD camera is superior to the foreign instrument in the entire spectral range 3900- 10830 A. Due to the presence of imaging and processing devices the CCD system can be used effectively in studying elongated features, especially in studying details on the solar surface, configuration of magnetic fields and velocity fields. Figures 4; references 3: 1 Russian, 2 Western.

Dynamics of Spacecraft With Elastic Oscillating Masses

927Q0114A Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 29 No 5, Sep-Oct 91 (manuscript received 20 Dec 90) pp 685-694

[Article by Yu. G. Markov and I. S. Minyayev; UDC 629.7]

[Abstract] A study was made of the problem of reduction of a spacecraft or satellite from an arbitrary initial motion to a stipulated angular position in an inertial or orbital coordinate system. In large-scale systems a deformability of its elements is observed. Increased

requirements on the accuracy of orientation of satellites dictate that allowance be made for the influence of elastic oscillations on motion of the structure as a whole relative to the center of mass. An effort was therefore made to obtain, in explicit form, differential equations describing small oscillations for characteristic configurations of an arbitrary axisymmetric elastic spacecraft. In these equations the coefficients are the projections of angular velocity of the satellite as well as their time derivatives, squares and products. The example considered is the dynamics of such a system in a segment of rotation during reorientation. It is assumed that the satellite is a dynamically symmetric mechanical system consisting of elastic (homogeneous and isotropic) and solid parts. The axis of dynamic symmetry is the axis of symmetry of the elastic part in an undeformed state. The motions of particles of the elastic medium relative to the solid body on part of the axisymmetric boundary are equal to zero and the other part of the boundary is free. It is assumed that the center of satellite mass (C) revolves in a stipulated orbit and that motion of the system relative to the center of mass is rotation as a whole and that the elastic oscillations exert no influence on orbital motion. Analytic expressions are derived for expressing deviations of angular velocity from the programmed value. References: 5 Russian.

Optimum Launching of Spacecraft From Lunar Surface Into Its Circular Satellite Orbit

927Q0114B Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 29 No 5, Sep-Oct 91 (manuscript received 28 Mar 90) pp 695-704

[Article by K. G. Grigoryev, M. P. Zapletin and D. A. Silayey; UDC 629.195.3]

[Abstract] A numerical solution is given for the problem of optimum control of the magnitude and direction of thrust of a jet engine with a constant rate of engine jet escape (high-thrust engine) when launching a spacecraft from the lunar surface into the circular orbit of an artificial lunar satellite in the central Newtonian field of lunar gravitation. A functional representing a compromise between the time of launching and the discharge of mass is minimized. The problem is solved on the basis of the maximum principle. A dependence of the bifurcation point of optimum control on the ratio of the compromise coefficients was discovered. Computations of the optimum trajectories were made in a wide range of orbital altitudes, thrust-to-weight ratios, specific thrusts and compromise coefficients. A precise numerical solution was found for the problem of the most rapid launching of a spacecraft from the lunar surface into a circular artificial lunar satellite orbit. A number of possible variants are illustrated by computations and graphs. Figures 13; references: 10 Russian.

Flux of Electrons With Energy Greater Than 100 MeV in Earth's Inner Radiation Belt

927Q0114C Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 29 No 5, Sep-Oct 91 (manuscript received 11 Oct 90) pp 711-716

[Article by L. V. Kurnosova, L. A. Razorenov and M. I. Fradkin; UDC 523.037:525.7]

[Abstract] An effort was made to explain the reason for the differences in the conclusions published in three earlier published articles which were based on data from the very same experiment (S. I. Nikolskiy, et al., KRATKIYE SOOBSHCHENIYA PO FIZIKE, No 11, p. 21, 1983; N. L. Grigorov, et al., IZV. AN SSSR: SER. FIZ., Vol 48, p 2208, 1984; TRUDY FIAN, Vol 162, p 101, 1985). The processing of additional measurements of electron fluxes made on 15 transits of the Cosmos 225 satellite across the Brazilian Magnetic Anomaly region confirmed the result obtained earlier that the fluxes of electrons, both albedo and trapped, are virtually identical in the Brazilian Anomaly and in adjacent regions. A comparison of the measured electron fluxes with the geomagnetic situation indicated a possible increase in the measured fluxes during an increase in geomagnetic activity. Since much of the data used in the earlier studies was obtained when there was very high geomagnetic activity it is possible that the high flux of electrons with $E_e > 100$ MeV cited there, also governing the form of the integral energy spectrum, was attributable precisely to that circumstance, although methodological errors also may have played a role. Figures 2; references 12: 11 Russian, 1 Western.

Refraction of VHF Radio Waves in Artificial Plasma Formations

927Q0114D Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 29 No 5, Sep-Oct 91 (manuscript received 25 Sep 90) pp 717-721

[Article by A. I. Kashirin, N. M. Klyuyeva, P. P. Mikhaylik and V. G. Chkalov; UDC 551.510.535]

[Abstract] The conclusions drawn concerning the characteristics of artificial plasma clouds obtained in active experiments using radio probing data for the most part have had a qualitative character. Accordingly, an attempt was made to determine the quantitative characteristics of artificial plasma clouds during radio probing at a frequency f considerably exceeding the maximum critical frequency f_{cr} in an artificial plasma cloud. Registry of variations in the amplitude of the received radio signal caused by radio wave refraction in the cloud with a change in the sighting parameter (the distance from the center of the cloud to the straight line connecting the emitter and receiver) can ensure determination of such characteristics. The measurements can be made at one or several (not mandatorily coherent) frequencies. The reactive attenuation of VHF radio waves during radio probing of artificial plasma clouds in the ionosphere was computed in the geometric optics approximation. The

possibility of determining the principal parameters of such clouds from characteristic variations of the power of the received radio radiation with a monotonic change in the sighting parameter during the time of an experiment is demonstrated. The results of a specific rocket experiment in which this method was used are given. Figures 2; references 6: 1 Russian, 5 Western.

'Elektron' System for Active Experiments With Electron Beam Injection

927Q0114E Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 29 No 5, Sep-Oct 91 (manuscript received 16 Aug 90) pp 722-728

[Article by M. B. Belotserkovskiy, V. F. Bykovskiy, S. B. Goryachev, A. A. Doroshkin, L. Yu. Kochmarev, G. I. Kuznetsov, R. M. Lapik, A. I. Livshits, I. N. Meshkov, V. N. Mozgunov, N. V. Pavlyuk, S. A. Rogashkov, A. V. Skvortsov, L. N. Smirnykh, Ye. M. Syresin, A. A. Tyutin, O. I. Trush and Ye. G. Shustin; UDC 543]

[Abstract] The "Elektron" system was developed for carrying out active experiments with electron beam injection at altitudes 100-200 km using MR-12 - MR-20 meteorological rockets. The outfit includes an on-board electron injector, module of diagnostic instruments and three separable autonomous diagnostic capsules. The injector has a high-perveance electron gun with beam modulation in the HF and LF ranges for exciting wave processes in ionospheric plasma. Two of the three autonomous diagnostic capsules are separated in diametrically opposite directions perpendicular to the rocket axis and the third is separated upward along the rocket axis. The diagnostic apparatus includes a data register-distributor ensuring registry of high-speed processes with a time resolution of several microseconds in 20 measuring channels and storage of data for the purpose of its retention in the case of telemetric failures during an experiment. Figure 1 is a block diagram of the electron injector, which serves as a basis for a detailed description of the structure and functioning of the outfit; a separate section is devoted to each part of the system (technical specifications are included). Figures 2 and 3 are photographs of one of the mentioned capsules and the system as a whole. The first experiment with the "Elektron-1" on an MR-12 rocket was conducted at Volgograd on 28 October 1989. Figures 3; references 8: 5 Russian, 3 Western.

Interaction Between Solar Wind and Mars. 'Fobos 2' Results

927Q0114F Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 29 No 5, Sep-Oct 91 (manuscript received 2 Aug 90) pp 741-753

[Article by T. K. Breus, A. M. Krymskiy, E. M. Dubinin, Ye. G. Yeroshenko, V. Ya. Mitnitskiy, N. F. Pisarenko, V. A. Styazhkin and S. V. Barabash; UDC 523.72]

[Abstract] The properties of the interface separating the regions of dominance of the solar wind and cold heavy plasma of planetary origin (planetopause), discovered in experiments on the Fobos 2 vehicle, were investigated. This chemical interface on the daytime side of the planet has a number of characteristics distinguishing it significantly from a magnetopause of the terrestrial type. Most importantly, there is a relative stability of the position of the plasma-planetopause (PP) interface when there are considerable (attaining an order of magnitude) changes in the dynamic pressure of the solar wind. The cold dense plasma which is present beneath the PP, in contrast to the magnetopause, is examined. Numerical simulation of the flow around Mars shows that stoppage (disappearance of fluxes) of solar wind protons at the PP interface may be a result of intensive charge exchange between solar wind protons and the neutral atmosphere and a substantial concentration of solar wind protons in the transition region near the planetopause, as is observed in the case of formation of a cometopause for Halley's comet or the chemical interface of the region occupied by ionospheric plasma and the interplanetary magnetic field near Venus during high P_{dyn} of the solar wind. The intensity of the neutral atmosphere at the solar activity maximum is evidently adequate in order to ensure a decrease in the flux of solar wind protons near the PP interface as observed by Fobos 2. Figures 9; references 31: 2 Russian, 29 Western.

Martian Magnetic Field and Magnetosphere

927Q0114G Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 29 No 5, Sep-Oct 91 (manuscript received 4 Jul 90 pp 754-789

[Article by Sh. Sh. Dolginov; UDC 523.47]

[Abstract] In this lengthy review of the literature it is shown that a joint analysis of magnetograms registered on the daytime and nighttime sides of Mars and data on the parameters of solar wind fields and plasma measured from the Mars-2, 3, 5 and Fobos-2 satellites reveal that Mars has its own intrinsic magnetic dipole field controlled by the solar wind. The parameters of the Martian dipole are determined. The dipole axis is deflected from the axis of rotation by 12+/-3°. The north magnetic pole of the dipole is situated in the southern hemisphere of the planet. The field density of magnetic energy at an altitude 870 km is determined; it exceeds the density of thermal energy of ions by a factor of 13. The magnetic field, not the ionosphere, is an effective obstacle to the solar wind when P_{wind} is less than or equal to 5×10^{-9} dyne x cm^{-2}. The width of the tail in the equatorial plane in the case of low dynamic pressures of the solar wind P_{wind} is greater by a factor of 1.6-1.8 than the width of the Venusian tail induced by its magnetosphere. The width of the tail of the Martian magnetosphere decreases considerably with an intensification of solar wind pressure. The situation with identical P_{wind} and B_z of the interplanetary magnetic field is different in the equatorial region and in the higher latitudes, where the field is more stable. There is a similarity between the dipole

fields of Mars and the Earth. The closeness of the dipole axis and the axis of planetary rotation and other factors suggest that the observed dipole field is related to the modern dynamo process in the liquid core. Figures 17; references 84: 12 Russian, 72 Western.

Dynamics of High-Energy Trapped Radiation in Earth's Inner Radiation Belt

927Q0114H Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 29 No 5, Sep-Oct 91 (manuscript received 13 Jun 90) pp 790-794

[Article by N. N. Volodichev, A. A. Gusev, Yu. V. Mineyev, G. I. Pugacheva and P. I. Shavrin; UDC 551.521.8]

[Abstract] The Cosmos-1686 satellite carried a K-1 instrument for registering fluxes of relativistic protons and electrons. The objective of the research was a study of the dynamics of fluxes of high-energy particles both in the capture region and outside it. The K-1 instrument was a telescope of two scintillation and two Cerenkov counters (a block diagram accompanies the text). The total flux of protons with $E_p > 500$ MeV and electrons with $E_e > 15$ MeV was registered. The satellite flight took place near an even solar activity minimum. Processed data for 1986 failed to reveal nonstationary processes in fluxes of high-energy particles outside the region of capture and quasicapture. The total proton flux had a smooth latitude variation. Early in February 1986 a series of solar flares of importance 3B was registered, causing the strongest magnetic storm during the last 20 years. The storm maximum was attained on 9 February; restoration began very rapidly, but full restoration required more than a month. Observations in the Brazilian Magnetic Anomaly for this period were analyzed. The instrument telescope axis was directed at an angle 45° to the zenith. Orbital revolutions which intersected the equator at the very same longitude on the descending orbital branch were selected for analysis. The dynamics of fluxes of high-energy particles at low altitudes revealed that the intensity of the fluxes at the maximum of the belt varied by almost an order of magnitude; the position of the maximum in the inner belt varied in the range from L about 1.2 to about 1.5; sometimes two maxima were observed in the inner belt. The gap between the maxima was at L about 1.3-1.4. The significance of changes before, during and after the event are described in detail. The observed changes were caused by magnetospheric disturbances and their dynamics must be studied in greater detail for formulating a nonstationary model at low altitudes. Figures 4; references 3: 1 Russian, 2 Western.

Radiation Conditions in 'Mir' Orbital System in September-October 1989

927Q0114I Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 29 No 5, Sep-Oct 91 pp 794-797

[Article by I. N. Arestova, V. I. Lyagushin, B. V. Marin, M. A. Sarayeva, M. V. Teltsov and P. I. Shavrin; UDC 551.521.8]

[Abstract] The Mir orbital station carried a scintillation detector ("Ryabina" instrument) and ionization chamber (R-16 dosimeter) for monitoring radiation conditions along its trajectory. The shieldings were 3 and 1.6 g/cm^2 respectively. A large proton flare was observed by the network of surface monitors on 29 September 1989. Instrumentation aboard the Mir station registered the hardness spectrum of solar protons in the range from 1.5 to 4.5 GV and the dose was measured behind a shielding 1.6 g/cm^2. The maximum planetary three-hour K_p index for that day did not exceed 2. The latitude effect was registered on seven segments of motion from north to south or south to north from the equator to a latitude +/-51.6°. Changes in the L, B parameters and altitude H during the time of motion along these segments are tabulated. Satellite and ground monitor data were compared and a satisfactory consistency was found. The integral dose for the entire flare was 600 mrad. In October 1989 two other large events were registered by the ionization chamber aboard the Mir. It was found that the temporal variation of the dose measured aboard the satellite in flare events is not unambiguously related to the temporal variation of the readings of an individual ground monitor and the maximum dose in orbit cannot be unambiguously determined from the maximum of neutron monitor counting increases. In addition to trajectory characteristics a contribution to these differences may be introduced by the differences in hardness spectra of flare particles registered on the Earth and in orbit. Figures 4; references: 2 Russian.

Three Spectral States of Source 1E1740.7-2942: From Standard Spectrum of Cyg X-1 Type to Annihilation Line in Spectrum

927Q0118A Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 17 No 11, Nov 91 (manuscript received 8 Aug 91) pp 963-974

[Article by R. A. Syunyayev, M. R. Gilfanov, Ye. M. Churazov, M. N. Pavlinskiy, S. A. Grebenev, G. G. Babalyan, I. A. Dekhanov, N. G. Khavenson, L. Bouchet, P. Mandrou, J.-P. Roques, G. Vedrenne, B. Cordier, A. Goldwurm, F. Lebrun and J. Paul, Space Research Institute, USSR Academy of Sciences, Moscow; National Space Research Center, Toulouse, France; Astrophysical Service, Nuclear Research Center, Saclay, France; Cosmic Radiations Research Center, Toulouse, France; UDC 524.354]

[Abstract] The source 1E1740.7-2942 is known as the brightest source of hard X-radiation near the dynamic center of our Galaxy. Three completely different spectral states of this source were discovered during observations of the region near the center of the Galaxy by the "Granat" observatory in 1990-1991. Information is given on the instrumentation employed. Behavioral characteristics during the three states are described. In almost all observations in 1990 the source had a spectrum similar to the spectrum of the well-known black hole candidate Cyg X-1 and a virtually constant flux in

the hard X-radiation region. The hardest of the spectral states observed by the "Granat" observatory on 13-14 October 1990 is characterized by a clearly expressed spectral high-energy rise in the region 300-600 keV, associated with annihilation processes in relatively cold electron-positron plasma. Recent observations in this region made in February-April 1991 revealed a low state of the source 1E1740.7-2942. The flux from the source was about 15-20 percent of the level observed in 1990. The strong variability of this source is evidence that it is an accreting object, not an individual neutron star similar to the pulsar in Crab nebula. [It is noted that an English version of this article was prepared for the Astrophysical Journal (Letters)—publication date unstated.] Figures 5; references 23: 2 Russian, 21 Western.

Wide-Band X-Ray Spectra of Black Hole Candidates, X-Ray Pulsars and Low-Mass Binary X-Ray Systems. Results From 'Kvant' Observatory

927Q0118B Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 17 No 11, Nov 91 (manuscript received 8 Aug 91 pp 975-984

[Article by R. A. Syunyayev, V. A. Arefyev, K. N. Borozdin, M. R. Gilfanov, V. V. Yefremov, A. S. Kaniovskiy, Ye. M. Churazov, E. Kendziorra, B. Mony, P. Kretschmar, M. Maisack, R. Staubert, S. Doeberainer, J. Englhauser, W. Pietsch, C. Reppin, J. Truemper, G. K. Skinner, M. R. Nottingham, H. Pan and A. P. Willmore, Space Research Institute, USSR Academy of Sciences, Moscow; Astronomical Institute, Tubingen University, West Germany; Exoatmospheric Physics and Astrophysics Institute, Max Planck Society, Garching, West Germany; Birmingham University, Great Britain; UDC 524.354]

[Abstract] The wide-band spectra of the brightest X-ray sources registered by the TTM, Hexe and Pulsar X-1 instruments of the "Kvant" observatory reveal differences in the hardness of the spectra of a neutron star with a weak magnetic field SCO X-1, the X-ray pulsars AO535+26, Vela X-1, LMC X-4 and the black hole candidates Cyg X-1, GS 2023+338, GS 2000+25 and 3C273. The article gives the X-radiation spectra typical for the three main classes of accreting relativistic objects forming parts of binary systems. The brightest sources with luminosities 10^{37}-10^{38} erg/s were selected. A high counting rate made it possible to carry out detailed spectroscopy in a wide energy range. The fundamental differences of the three types of X-ray sources are illustrated. The sources which are black hole candidates and X-ray novae have the hardest spectra of those observed by telescopes on the "Kvant" observatory. Crab nebula also is characterized by an anomalously hard X-ray spectrum, but it has a different (nonaccretional) nature. Hard X-radiation spectra are characteristic not only of sources which are black hole candidates, but only the latter among the accreting sources have hard X-radiation "tails." [In abbreviated form this article will be published in the transactions of the conference "Frontiers of X-Ray Astronomy. Proc. 28th Yamada Conference, 1991 (in press).] Figures 4; references 29: 6 Russian, 23 Western.

Detection of Quasiperiodic Oscillations of X-Radiation of Black Hole Candidate GX339-4

927Q0118C Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 17 No 11, Nov 91 (manuscript received 8 Aug 91) pp 985-990

[Article by S. A. Grebenev, R. A. Syunyayev, M. N. Pavlinskiy and I. A. Dekhanov, Space Research Institute, USSR Academy of Sciences, Moscow; UDC 524.354]

[Abstract] Like other X-radiation black hole candidates (Cyg X-1 and IE1740.7-2942), GX339-4 (4U1658-48) exhibits three X-radiation states: "high," when the flux from the source in the standard energy range 2-10 keV is at the level 300-500 milliCrab and the source has a soft thermal spectrum with an effective temperature about 10^7K, "low" with a flux 50-150 milliCrab and a hard comptonized spectrum and an "off" state with a flux less than 30 milliCrab. Observations made with the "Granat" observatory in 1990-1991 made it possible to study the source behavior in all three states. Each of these states is analyzed in detail. Two of the spectral states of GX339-4, during which it is bright in X-ray light, correspond to two different regimes of disk accretion into a black hole. Either the spectrum of an optically thick disk or a spectrum with a hard X-radiation tail, associated with comptonization of low-frequency photons in high-temperature electron plasma, are observed. The thermal instability of the accretion current in the disk in a regime when a "hard" spectral state is observed may be the cause of appearance of flicker noise. The discovery of low-frequency quasiperiodic oscillations of the X-radiation of GX339-4 can be regarded as further evidence that the accretion in this source is going to a black hole. Figures 2; references 15: 1 Russian, 14 Western.

Optical Identification of X-Ray Transient Source KS 1947+300

927Q0118D Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 17 No 11, Nov 91 (manuscript received 5 May 91) pp 991-993

[Article by K. N. Grankin, V. S. Shevchenko and S. D. Yakubov, Astronomical Institute, Uzbek Academy of Sciences, Tashkent; UDC 524.35]

[Abstract] In June 1989 the X-ray spectrograph with a TTM coding mask in the "Kvant" observatory registered the X-ray transient source KS 1947+300 (in Cyg) with a flux 70 mCrab in the range 2-27 keV. In August the flux weakened by a factor greater than 7, indicating a strong

flux change during the course of observations. The source coordinates were determined during observations. Due to the high localization accuracy (30" of arc) it was possible with a high probability to identify the source with a star with about 14.2V. A search for a probable candidate was made in the optical range in October 1990 using a 60-cm Zeiss telescope. Two stars fell in the circle of localization errors. A map of the neighborhood of these stars is given. The most probable candidate is a blue, possibly variable star with a brightness change in the limits $14^m.17$-$14^m.27$V. Its observed parameters are given in a table. However, it is desirable that the spectra of both stars falling in the circle of errors be determined because it is not impossible that the second star also may be an optical candidate for KS 1947+300. Figure 1; references 2: 1 Russian, 1 Western.

Fractal Properties of Sunspots

927Q0118E Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 17 No 11, Nov 91 (manuscript received 28 May 91) pp 1013-1019

[Article by L. M. Zelenyy and A. V. Milovanov, Space Research Institute, USSR Academy of Sciences, Moscow; UDC 523.982]

[Abstract] There is a striking analogy between the formation of fractal aggregates in aggregation processes and sunspot formation in the solar photosphere. A fractal model of sunspots is formulated. The formation of fractal structures is regarded as the result of aggregation of magnetic tubes of force into a fractal cluster. Expressions are derived for the magnetic field distribution in the spot umbra and penumbra, as well as an analytic expression for the fractal dimension from the condition of a minimum of the free energy of the cluster. The relationship between the fractal dimension of a spot and the distribution function of plasma particles is discussed. A distribution function corresponding to the observed fractal dimension value is found. The fractal model makes possible a qualitative explanation of sunspot form and morphology of spots with a well-developed penumbra. The magnetic field distribution predicted by the model is in fairly good agreement with experimental data. The fractal properties of sunspots are dependent on the distribution function for plasma particles. There is evidence of an essentially nonequilibrium nature of the physical processes leading to sunspot formation. Figure 1; references 8: 5 Russian, 3 Western

Neptunian Arcs as Chains of Epitons in Continuous Transparent Ring

927Q0118F Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 17 No 11, Nov 91 (manuscript received 13 Jun 91 pp 1020-1030

[Article by N. N. Gorkavyy, Astronomy Institute, USSR Academy of Sciences, Moscow; UDC 523.48]

[Abstract] It was postulated by N. N. Gorkavyy in 1989 that the existence of an arc is possible if it constitutes a set of epicyclic vortices (epitons) within the dust ring. The particles of such an elliptical vortex revolve about the center of mass in epicycles. The precise equality of the semimajor axes is responsible for the equality of the periods of orbital revolution and therefore the vortex is stable and does not dissipate along the orbit. A continuous narrow ring results in an equality of the semimajor axes of the epitons, which is a guarantee of stability of many tens of vortices. The Voyager 2 photographed a regular chain of compact clusters situated in the Neptunian arcs. The existence of such a structure is direct confirmation of the epiton model; no other hypothesis explains the possibility of existence of internal arc structure. Although the problem of the detailed picture of the breakdown of a narrow gravitationally unstable ring into a series of epitons remains open, computations of the stability of an already forming system of arcs confirm the viability of the epiton model. It is clear that epitons, stable local multiparticle objects forming in differentially revolving disks of macroparticles, may exist elsewhere than in the rings of Neptune. The role of such objects in the formation and dynamics of the solar system remains to be evaluated. Epitons appear to be closely related to large-scale atmospheric vortices like the Great Red Spot of Jupiter. Figures 4; references 39; 12 Russian, 27 Western.

Dispersion Properties of Near-Spacecraft Plasma During Injection of Electron Beam

927Q0124 Moscow GEOMAGNETIZM I AERONOMIYA in Russian Vol 31, No 6, Nov-Dec 91 pp 1011-1016

[Article by A. Yu. Bogomolov, V. A. Fedorov, Radioengineering Institute, USSR Academy of Sciences; UDC 533.95]

[Abstract] Experiments have shown that the injection of an electron beam and the presence of a large positive potential on the spacecraft lead to strong disturbances in the plasma near the spacecraft. One of the signs of that phenomenon consists in wave processes that serve as a source of emissions. This paper studies the dispersion properties of magnetically active plasma in the vicinity of a spacecraft that is a sphere with a radius R_0 and that injects a beam of electrons along the Earth's magnetic field. The researchers examine processes for moments in time in which t is much less than ν^{-1}, R_c/υ_i, where ν is the frequency of collisions of electrons and other plasma particles, R_c is the characteristic size of the disturbed plasma region, and υ_i is the velocity of the plasma ions. It is concluded that the difference between frequencies ω_0 and $\omega_{1\text{-}6}^{(3)}$ is small, suggesting that frequency fluctuations occur at the Langmuir frequency when injection is in the F layer. Another conclusion was that if $H_{b\varphi}/H_0$ is greater than or approximately equal to 1, the magnetic field of the electron beam has a substantial effect on plasma frequency fluctuations and, consequently, on measurement of plasma electron concentration near the

spacecraft. A third conclusion was that if $H_{b\varphi}/H_0$ is much less than 1, the frequency of plasma fluctuations is equal to ω_{UHR}. If ω_{eH}/ω_0 is much less than 1, then $\omega \approx \omega_0$. References 17: 10 Russian, 7 Western.

X-Ray Research on Pulsar Hercules X-1 on 'Astron' Automatic Station

927Q0140A Moscow ASTRONOMICHESKIY ZHURNAL in Russian Vol 69 No 1, Jan-Feb 92 (manuscript received 14 Dec 90) pp 82-105

[Article by Ye. K. Sheffer, I. F. Kopayeva, M. B. Averintsev, G. S. Bisnovatyy-Kogan, I. M. Golynskaya, L. S. Gurin, A. V. Dyachkov, V. M. Zenchenko, V. G. Kurt, T. A. Mizyakina, Ye. N. Mironova, V. A. Sklyankin, A. S. Smirnov, L. G. Titarchuk, V. M. Shamolin, Ye. Yu. Shafer, A. A. Shmelkin and F. Giovannelli, Astronomical Center, Physics Institute, USSR Academy of Sciences imeni P. N. Lebedev; State Astronomical Institute imeni P. K. Shternberg; Space Research Institute, USSR Academy of Sciences; Space Astrophysics Institute, Frascati, Italy; UDC 524.354.4-735]

[Abstract] A series of observations of the X-ray pulsar Her X-1 was made from the "Astron" automatic station in 1983-1987. An "off" phase of the X-radiation flux of this source was discovered simultaneously with similar observations by the EXOSAT satellite. A flux constituting approximately 5 percent of the maximum value was registered. The X-radiation spectrum in this state is interpreted as a spectrum obtained with reflection of the direct flux of X-radiation in the hard energy range from the photosphere of the normal star HZ Her, but in the soft X-radiation range—with its scattering by the corona of the star and disk. It is postulated that the observed prolonged low state of the flux is attributable to a temporary increase in the rate of accretion on the neutron star, which led to occultation of the region of emission generation from the terrestrial observer. A decrease in the observed period of the pulsar during the prolonged low state is evidence supporting a temporary increase in M. In the proposed model the considerable variations in structure of the main pulse are attributed to an increase in occultation of the generation region by matter near the limb due to disk precession. The relatively rapid disappearance of the first peak of the main pulse indicates that the direction of disk precession must coincide with the direction of neutron star rotation. Such a relatively simple geometric model can explain many other observational facts such as the phase difference of brightness curves in the hard and soft X-ray ranges and probably finer effects of variations of the pulsar brightness curve with the phase of the 35^d cycle both in the "high on" and the "low on" states. Figures 15; references 79: 10 Russian, 69 Western.

Determination of Some Geodynamic Parameters From Processing of Observations From LAGEOS and 'Etalon-1' Artificial Earth Satellites

927Q0141A Kiev KINEMATIKA I FIZIKA NEBESNYKH TEL in Russian Vol 8 No 1, Jan-Feb 92 (manuscript received 8 May 91

[Article by A. N. Marchenko, Lvov Polytechnic Institute; UDC 521.93-14]

[Abstract] An analysis was made of laser observations from the LAGEOS (1983-1985) and 'Etalon-1' (1989) artificial earth satellites for refining the orbital elements of the satellites, the Earth's rotational parameters, the coefficients of direct light pressure C_R and empirical acceleration C_T, the coordinates of 30 observation stations, the product of the gravitational constant and the Earth's mass fM, the value of the harmonic coefficient C_{20}, some fundamental constants in geodesy and astronomy, as well secular variations of the zonal geopotential coefficients. An algorithm for evaluating the parameters is outlined. A package of GEORAN-2 programs (with application of MERIT standards) was used in solving the formulated problem: 1) for processing LAGEOS laser observations; 2) for processing laser 'Etalon-1' observations; 3) for the joint processing of LAGEOS and 'Etalon-1' observations (combined solution). In the latter case the stability of the solution for the Earth's rotational parameters and station coordinates is increased (in comparison with the second case). There is a high correlation in the joint determination of C_T and potential variations. References 14: 5 Russian, 9 Western.

Astrometric Databank at Pulkovo Observatory and Some Examples of Its Use

927Q0141B Kiev KINEMATIKA I FIZIKA NEBESNYKH TEL in Russian Vol 8 No 1, Jan-Feb 92 (manuscript received 18 Jun 91 pp 89-96

[Article by K. A. Kandaurova and Ye. V. Khrutskaya, Main Astronomical Observatory, USSR Academy of Sciences, Pulkovo; UDC 521.9:002]

[Abstract] The principles of organization, programs used and procedures for exploitation of the Pulkovo Observatory astrometric databank are presented. The real use of this databank in fundamental astrometry began in 1986-1987. It is now possible, for any star, to retrieve all pertinent information, both astrometric and astrophysical. This has greatly broadened research capabilities and is useful in detecting different sources of systematic errors in the fundamental system and in dependent reference systems. Accordingly, in the databank, in addition to catalogues containing the positions and proper motions, there are also catalogues of parallaxes, radial velocities, spectral classes, luminosity classes and other data. Data are entered into individual catalogues. In organizing the data emphasis was on the possibilities of on-line sampling of data and different kinds of compilations from several sources. When preparing the material for individual catalogues the data lacking in them were taken from all available sources, including published works. A table gives a listing of catalogues and stars in the databank and entered in the ASTCAT database. The possibilities of use of this database in practical work are discussed and the role of personal computers in the hands of individual researchers in exploiting this databank is examined. References 14: 5 Russian, 9 Western.

New X-Ray Sources GRS1734-292, GRS1736-297 and GRS1747-312 Discovered in Region of Center of Galaxy Using ART-P Telescope Aboard 'Granat' Observatory

927Q0150A Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 18 No 3, Mar 92 (manuscript received 25 Nov 91) pp 217-227

[Article by M. N. Pavlinskiy, S. A. Grebenev and R. A. Syunyayev, Space Research Institute, Russian Academy of Sciences, Moscow; UDC 524.354]

[Abstract] Three new X-ray sources were discovered in the course of a regular series of observations of the region near the center of the Galaxy in September-October 1990 using the ART-P telescope aboard the "Granat" observatory. The position of the sources was determined with an accuracy better than one and a half minutes of angle. One of the sources, GRS1747-312, which on 9-10 September 1990 had a luminosity (about 4.5 x 10^{36} erg/s in the energy range 3-12 keV) comparable to that of the brightest sources in this field, A1742-294 and 1E1740.7-2942, after a month was not detected at the response level of the ART-P telescope. This was the second transient source registered using the ART-P telescope in the region of the center of the Galaxy over the course of a half-year (the first such source was GRS1741.9-2853, observed in March-April 1990 but not detected during the autumn observations). The source had a soft thermal spectrum similar to the spectrum of bright X-ray novae. The other two earlier unknown sources, GRS1734-292 and GRS1736-297, had hard power law spectra with strong absorption in the low-energy region. Their luminosity in the range 3-12 keV was more than an order of magnitude less than the luminosity of GRS1747-312. A table gives pertinent data (coordinates, right ascension, declination, flux and luminosity) on these bodies and their positions are pinpointed on sky charts. Figures 4; references 11: 4 Russian, 7 Western.

Martian Composition, Structure and Gravity Field

927Q0109A Moscow ASTRONOMICHESKIY VESTNIK in Russian Vol 25 No 5, Sep-Oct 91 (manuscript received 26 Apr 91) pp 515-547

[Article by V. N. Zharkov, Ye. M. Koshlyakov and K. I. Marchenkov, Earth Physics Institute imeni O. Yu. Shmidt, USSR Academy of Sciences; UDC 523.42:551]

[Abstract] This review contains data which can be used in drawing conclusions concerning Martian internal structure. The planet seems to have a very thick crust. As a result, the Martian mantle must be highly impoverished with respect to incompatible elements, including radioactive impurities. In the planetary interior there are too few energy sources for maintaining well-developed convection in the mantle. Arguments are given indicating that the planetary core, in addition to sulfur, may contain hydrogen, which like S is an element reducing the melting point. The correlation between the temperature distribution and the temperature of effective viscosity in the mantle indicates a low-temperature distribution in the planetary interior. The melting points of the postulated compositions of the Martian core are sufficiently low that the planetary core must be in a liquid state, despite the low temperatures of the planetary interior. The matter of the energy sources in the core necessary for generating the magnetic field remains open. A determination of the radius of the core and its state by seismological methods is an important task for future research. The petrological model indicates that ¾ of the mantle consists of olivines with an iron content greater by a factor of 2-3 than in terrestrial olivines. Since the phase diagram of olivines is well known, use of seismological methods for determining the depth of the onset of the transition of olivines into a spinel modification would give a reference point for temperature at this depth and in essence would give the temperature distribution in the interior. Another important task in Martian seismology is determining the thickness of the Martian crust and the relief of the Martian Moho. Confirmation of the thick crust hypothesis would indicate the correctness of modern concepts on the origin and evolution of the planet. The review goes into great detail on the joint interpretation of topography and the gravity field. However, the detail of the data makes it possible to obtain significant results only with respect to the largest structures. Figures 13; references 50: 9 Russian, 41 Western.

Lunar Surface Described Using Remote Observational Data

927Q0109B Moscow ASTRONOMICHESKIY VESTNIK in Russian Vol 25 No 5, Sep-Oct 91 (manuscript received 21 Mar 91) pp 569-577

[Article by V. V. Shevchenko, Yu. G. Shkuratov and N. V. Opanasenko, State Astronomical Institute imeni P. K. Shternberg; UDC 523.34]

[Abstract] The principal results of remote investigations of the lunar surface are given on the basis of surface and space observational data. Proceeding on the basis of the definition of remote research as a system of methods for measuring the spatial distribution of static fields, flows of particles and electromagnetic radiation, an analysis is made of the present-day level of study of these lunar surface characteristics. Magnetic field strength was estimated by direct and indirect methods. The characteristics of the chemical composition of surface rocks were determined by registry of fluxes of alpha particles and spectrometry in the gamma- and X-ray ranges. Estimates of the mineralogical composition were based on study of surface albedo in the visual range, in the range of the vacuum UV, in the IR range and in individual sectors of the visual range by colorimetry methods and spectrophotometry. The structural characteristics of the lunar ground surface layer were studied by radar and also use of measurements of the phase dependence of brightness and polarization of light reflected by the moon. Data collected on these characteristics made it possible to compile a series of thematic maps of the lunar surface. Figures 4; references 37: 18 Russian, 19 Western.

Relative Spectrophotometry of Halley's Comet in Near-IR Region

927Q0109C Moscow ASTRONOMICHESKIY VESTNIK in Russian Vol 25 No 5, Sep-Oct 91 (manuscript received 3 Apr 91) pp 599-601

[Article by V. F. Yesipov, P. P. Korsun, O. Mamadov and V. G. Parusimov, Astrophysics Institute, Tajik Academy of Sciences; UDC 523.64]

[Abstract] Spectral observations were made with the AZT-8 telescope at the Gissar Astronomical Observatory in the Tajik SSR during the time of appearance of Halley's comet in 1985-1986. Spectrographic observations were made with an SPM-1 spectrograph with a two-stage fiber optic image converter and a grating with 600 rulings/mm. Fifty spectrograms were obtained in October-December 1985 and April-May 1986 for regions 5150-7500 and 6000-9000 A with a line dispersion 160 A/mm. Five photographs were selected from this series of spectrograms registered in the near-IR region in the wavelength range 6000-9000 A. The following bands were identified: CO (3-0), (4-1), (10-2), (11-3); H_2O^+ (0,7,0), (0,6,0), NH_2 (0,6,0), (0,5,0); red system CN (2.0), (3-1), (4-2), (5-3) and C_2 (2- 0) of the Phillips system band. Among the CN cross sections an asymmetric distribution was discovered which is attributable to the influence of jets in the region near the cometary nucleus. Figures 3; references 6: 3 Russian, 3 Western.

Petrology of Lunar Rock

927Q0110 Moscow ASTRONOMICHESKIY VESTNIK in Russian Vol 25, No 6, Nov-Dec 91

[Article by M. I. Korina; UDC 523.34]

[Abstract] Data on materials brought back by the Apollo 11-17 missions and the Luna-16, -20, and -24 missions are summarized in terms of the mineralogy, chemistry, and petrology of highland and mare rocks. The researcher concludes that highland rocks are products of an early differentiation of lunar material in the final stage of accretion. They appeared as a result of powerful impact processes. Selective evaporation and dissipation in the accretional impact events produced geochemical features like the scarcity of volatiles and water. Magmatic differentiation of alloys that formed during the release of energy by rapid accretion resulted in the near-surface accumulation of plagioclase and in the appearance of a magnesian series and a ferroanorthosite series. KREEP basalts probably erupted to the surface as a result of an endogenous heat source. The lack of uniformity in the crust is a function of local differences in matter. Lunar mare basalts vary in composition and structure. They crystallized at or near the surface. Magma sources were at depths of 100-400 km. The researchers divided the basalts into two groups, based on age and Ti content, with the more primitive basalts being the relatively young basalts with lower Ti content. Basalt magmas underwent a complex history of development, with their compositions based on partial core melting, gravitational differentiation, and hybridization. Figures 8, references 29: 16 Russian, 13 Western.

Update of Maps of Phobos on the Basis of Fobos-2 Photographs

927Q0094 Moscow GEODEZIYA I KARTOGRAFIYA in Russian No 4, Dec 91 pp 28-31

[Article by V. I. Kravtsova and Ye. G. Kharkovets; UDC 528.92(15)]

[Abstract] Images of Phobos made with from the Fobos-2 probe 200-1000 km above the moon in 1988-1989 were used in a cartographic analysis whose purpose was to update earlier compiled maps. The analysis was based primarily on 13 narrow-angle photographs that covered most of the surface of Phobos from 60° to 280° longitude and that were compared against the Turner (1978) and Thomas (1979) maps, the U.S. Geological Survey map (1989), and Moscow Institute of Geodesy, Aerial Photography, and Cartography Engineers [MIIGAiK] map (1988). The effort revealed three craters and 10 wrinkles that were not on the U.S. Geological Survey map. Dark spots whose forms were unaffected by changing illumination were also found. The Fobos-2 photos added nine craters and 10 wrinkles to the Thomas Mercator map. The area of the Turner map encompassing 80-280° long and +60° to -50 ° lat was changed considerbly (Turner's map was based on Mariner 9, whose photos were of a low resolution). A total of 34 craters and 10 wrinkles were added to the MIIGAiK maps. Figures 3, references 4: 1 Russian, 3 Western.

How Reliable is the Analysis of Observational Data From the Viking 1 and Viking 2 Spacecraft on the Optical Properties of the Martian Atmosphere?

927Q0152A Moscow ASTRONOMICHESKIY VESTNIK in Russian Vol 26 No 1, Jan-Feb 92 (manuscript received 4 Apr 91, after revision 19 Sep 91) pp 28-38

[Article by A. V. Morozhenko, Main Astronomical Observatory, Ukrainian Academy of Sciences; UDC 523.43]

[Abstract] An analysis of data on the optical properties of the Martian atmosphere during the periods of its high transparency, which were obtained on the basis of observations by the Viking 1 and Viking 2 Landers in 1976, led to the conclusion that: the effective radius of particles was not consistent with the results of polarization measurements of Mars; during periods of registry of solar images the optical characteristics of the planetary atmosphere were unstable. Since the latter was not taken into account in the processing of observations there is weighty evidence for doubting the reliability of published data on the optical characteristics of the Martian atmosphere, especially since estimates based on an analysis of photometric and polarization measurements also are encumbered by errors. The methodological errors in data processing are examined in detail. It must be concluded that the problem of the optical properties of the Martian atmosphere during periods of its high transparency remains open and this must be taken into account in the planning of new space experiments, although correct reprocessing of Viking Lander data might make it possible to obtain reliable optical depth estimates. Figures 3; references 25: 11 Russian, 14 Western.

What is Known About Aerosol in the Martian Atmosphere?

927Q0152B Moscow ASTRONOMICHESKIY VESTNIK in Russian Vol 26 No 1, Jan-Feb 92 (manuscript received 23 Oct 91) pp 39- 45

[Article by V. I. Moroz, Space Research Institute, Russian Academy of Sciences; UDC 523.43]

[Abstract] The author begins with critical comments concerning an article by A. V. Morozhenko published in this same number of the journal concerning the reliability of Viking Lander data on the optical properties of the Martian atmosphere, some of whose arguments and conclusions are deemed unsound. The article itself is a concise review of the principal properties of Martian aerosol (composition, optical depth, size distribution). Particular attention is given to the so-called constant haze present on the planet. New data on this haze obtained in several experiments on the 'Fobos' mission are analyzed. In particular, the vertical profile of the extinction coefficient was measured for the first time. The total optical depth was about 0.2, only half as great

as during the time of the Viking observations in the same season, and the particle size distribution was narrower than during those observations. The chemical composition of the aerosol medium can be broken down into two principal categories: mineral dust and ice or two-component particles. The principal type of condensate is evidently H_2O ice, but at great altitudes there may be thin clouds of solid CO_2. Two-component particles are those consisting of a mineral nucleus and an ice envelope. It is this subject to which the bulk of the analysis in the article is devoted. Figures 2; references 19: 3 Russian, 16 Western.

Size Distribution of Particles Forming During Ablation of Meteorites Under Simulated Conditions

927Q0152C Moscow ASTRONOMICHESKIY VESTNIK in Russian Vol 26 No 1, Jan-Feb 92 (manuscript received 5 Mar 91), after revision 10 Jun 91) pp 72-76

[Article by V. A. Bronshten, V. N. Zelenin and S. G. Mikheyenko, Committee on Meteorites, Russian Academy of Sciences; Moscow Engineering Physics Institute; UDC 523.68]

[Abstract] In laboratory research on the size distribution of particles separating during ablation samples of the Tsarev stony and Sikhote Alin iron meteorites and also steel and basalt were subjected to a stream of hot gas in an electric arc plasmatron (air-nitrogen mixture temperature 4500 K, heat flow onto sample 10 MW/m^2, pressure 10^5Pa). The size distribution of melt particles separating from the meteorite mass is represented well by a log-normal law with two peaks corresponding to mean diameters of particles 2-4 and 0.4-1.2 μm whose parameters are governed by the dispersion conditions and the characteristics of the material. The first of these peaks corresponds to small particles forming in edge effects in the process of fragmentation of the melt stream and the second corresponds to condensing particles. The main peak corresponded well to a value determined by the critical Weber number (8). The fraction of small particles arising during destruction of the melt into larger droplets as a result of edge effects and in the evaporation-condensation process did not exceed several percent. The rates of loss of mass, as given in a table, are in good agreement with the results of theoretical studies. Figures 2; references: 4 Russian.

Spectral Observations of Giacobini-Zinner Periodic Comet

927Q0152D Moscow ASTRONOMICHESKIY VESTNIK in Russian Vol 26 No 1, Jan-Feb 92 (manuscript received 9 Apr 91) pp 109- 111

[Article by V. F. Yesipov, G. A. Lukina and O. Mamadov, Astrophysics Institute, Tajik Academy of Sciences; UDC 523.642]

[Abstract] The Giacobini-Zinner periodic comet was observed spectrally at the Crimean Station of the State Astronomical Institute on 16-17 September 1985 soon after its passage through perihelion, at which time the heliocentric distance of the comet was 1.040 AU. The spectra were registered using a 125-cm telescope with a spectrograph outfitted with a two-stage image converter. During two nights about 15 spectrograms of the comet were registered with exposures from 30 s to 10 min. Cometary brightness was $9^m.2$. A diffraction grating with 1200 rulings/mm was used in combination with the telescope and spectrograph, ensuring a dispersion 108 A/mm. On these spectra it was possible to identify the Swan bands C_2 ($\Delta v = +2, +1.0, -1$), CN(0.1) and CH(0,0) and many bands CO, H_2O^+ and H_2. Photometric measurements indicated that the spectrophotometric gradient is 5.1, which corresponds to a spectral class gK3 and a color temperature 3674 K. The photometric procedures used are described. The photometric data show that in the scattering of sunlight in the visible region in the cometary atmosphere the main role is played by particles of submicron size and large particles scatter light without regard to wavelength. A table gives the identification ofthe spectral lines and bands in the cometary spectrum. References 5: 3 Russian, 2 Western.

Television Observations of Meteors at Dushanbe in 1979

927Q0152E Moscow ASTRONOMICHESKIY VESTNIK in Russian Vol 26 No 1, Jan-Feb 92 (manuscript received 9 Apr 91) pp 112- 114

[Article by I. F. Malyshev, Astrophysics Institute, Tajik Academy of Sciences; UDC 523.68-520.34]

[Abstract] The instruments and methods used in making television observations (625 lines, 25 frames/s, field of view 20 x 30°, with a "Yupiter-3" objective) of meteors at the Gissar Astronomical Observatory of the Astrophysics Institute, Tajik Academy of Sciences, during the period 25 July-2 August 1979 are described. During the period 25-27 July the axis of the objective was directed to a point in the celestial sphere with the coordinates A = 190°, z = 31° and during the period 28 July-2 August to a point with A = 180°, z = 35°. A total of 180 meteor photographs were obtained during 35 hours of observations. A series of histograms gives the distributions of the hourly numbers of observed meteors. The greatest activity was observed from 0100 to 0400 local legal time. Known formulas were used in computing azimuth, zenith distance of the radiant, center of the observed region of the sky and midpoints on the meteor trajectories. Then the meteors were broken down into individual groups having similar radiants. The results of processing of 21 meteors having a brightness from -9 to +2.4 absolute star magnitude are given. Several meteor streams fell during this period; some of these meteors associated with particular streams are listed in a table. Figure 1; references 3: 2 Russian, 1 Western.

Observations of Noctilucent Clouds and Aerosol Layers in Strato-Mesosphere From 'Salyut-7' and 'Mir' Orbital Stations

927Q0152F Moscow ASTRONOMICHESKIY VESTNIK in Russian Vol 26 No 1, Jan-Feb 92 (manuscript received 12 May 91) pp 115-125

[Article by A. I. Lazarev, V. N. Lebedinets, L. A. Mirzoyeva, V. P. Savinykh and V. G. Titov, State Optical Institute imeni S. I. Vavilov; Experimental Meteorology Institute; UDC 551.593.653]

[Abstract] The history of observations of noctilucent clouds and similar formations from space is reviewed. The article gives some results of systematic observations of noctilucent clouds, equatorial mesospheric clouds (EMC), polar mesospheric clouds (PMC) and light scattering layers from aboard the "Salyut-7" and "Mir" orbital stations in 1985 and 1988. Emphasis is not solely on the presentation of new observational data, but on clarification of the most interesting geophysical formations, regularities in their appearance and attempts at their theoretical interpretation. EMC and PMC differ substantially from one another. Whereas PMC are frequently observed in the form of extensive fields with dimensions of thousands (or even tens of thousands) of kilometers, EMC, at least in one of the sections, initially have short dimensions of about 100 km, but then may be drawn out, acquiring a longitudinal configuration. The origin of EMC, PMC and noctilucent clouds is discussed in detail in the light of the theory of a cometary origin of water in the upper atmosphere. At least three types of noctilucent clouds are defined: "background," which appear only during summer in the high latitudes when there are very low temperatures at the mesopause 160-170 K; "local," which may appear over any point on the Earth's surface and which are associated with an influx of small comets; clouds associated with volcanic eruptions (an increase in the frequency of occurrence of noctilucent clouds is observed one-three years after volcanic eruptions). Figures 4; references 26: 23 Russian, 3 Western.

Experience in Plotting Photometric Map of Normal Albedo of Martian Surface

927Q0151A Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 18 No 3, Mar 92 (manuscript received 1 Nov 91) pp 271-278

[Article by V. G. Teyfel, N. V. Sinyayeva, A. N. Aksenov and G. A. Kharitonova, Astrophysics Institute, Kazakh Academy of Sciences, Alma Ata; UDC 523.43]

[Abstract] Despite the long history of the study of Mars there are virtually no maps of its surface albedo based on detailed photometry. This article describes the methods used and the results of photometric and computer processing of photographic images of Mars registered near the opposition of 1990 and used in constructing a normal albedo map in red light (for an effective wavelength 0.65 μm). The observations were made at the Assy Observatory of the Astrophysics Institute, Kazakh Academy of Sciences, during the period September 1990-March 1991. Detailed photometric processing was carried out for 36 of the best photographs when the phase angle of Mars varied from -6° to +5° and the image diameter was not less than 8 mm. The intensity distributions were measured and the coefficients of darkening toward the disk limb (global and local) were determined. These measurements were made in reduction of the Martial images for darkening toward the limb. Fragments of an albedo map and a general map in an isophot representation in the form of half-tone and three-dimensional images were constructed and are reproduced in the text. The global coverage is incomplete, data being lacking for longitudes between 220 and 288°, which at the time involved could be observed only from the western hemisphere. Figures 4; references 8: 4 Russian, 4 Western.

Measurement of Radiation Dose on Mir Station During Solar Proton Events in September-October 1989

927Q0111A Moscow GEOMAGNETIZM I AERONOMIYA in Russian Vol 31 No 5, Sep-Oct 91 (manuscript received 21 Nov 90) pp 928-930

[Article by I. V. Tverskaya, M. V. Teltsov and V. I. Shumshurov, Nuclear Physics Scientific Research Institute, Moscow State University; UDC 524.1:523.9]

[Abstract] Radiation dose variations were measured within the Mir station during solar cosmic ray increases in September-October 1989. The Mir orbital parameters at that time were: apogee 410 km, perigee 380 km, inclination 51.6°. R-16 dosimetric equipment was used, ensuring registry of the radiation dose in the range 0.005-100 rad with a dose intensity from 0.5 mrad/hour to 50 rad/hour (accuracy +/-20 percent). The R-16 uses a tissue-equivalent ionization chamber with an electrostatic relay; shielding for the most part is about 2 g/cm^2 Al. The main contribution to the dose was protons with an energy equal to or more than 40 MeV and electrons with an energy equal to or more than 4 MeV. The increases in solar cosmic rays in September-October 1989 were among the most powerful during the entire period of observations on spacecraft. They were caused by a series of solar flares. Four solar proton intensity increases were registered. Each of these events is analyzed individually. These findings revealed how great a spread there is between experimental data and model computations of the limits of penetration of high-energy solar protons into the magnetosphere. A sharp increase in the dose by 2 rad, occurring over the course of four hours, constitutes a serious radiation danger for the crews of space stations, especially with emergence into open space. Models of extreme situations in the magnetosphere must be constructed on the basis of the latest scientific results. Figure 1; references 6: 3 Russian, 3 Western.

Semenov Discusses Future Space Systems, Projects

927Q0092A Moscow ZEMLYA I VSELENNAYA in Russian No 5, Sep-Oct 91 pp 3-11

[Article by Yu. P. Semenov, corresponding member, USSR Academy of Sciences, general designer, Energiya Scientific Production Association: "Soviet Rocket-Space Technology: Today and Tomorrow"]

[Text] Thirty-four years separate us from that moment when a small silvery sphere, carried in the nosecone of a modified ballistic missile, with its entry into a circumterrestrial orbit opened a new era in the Earth's history, the space era.

During this time new, more powerful and improved types of boosters, putting loads beyond the Earth's limits, launching manned spaceships and permanently operating orbital stations, have made their appearance.

The improvement in space technology is continuing. What have been the successes and what are the prospects?

Booster Rockets

In implementing the broad-scale programs for studying and exploiting near and distant space an important role is played by the apparatus used in putting spacecraft into circumterrestrial orbits and onto interplanetary trajectories. With the development of a new carrier and its putting into operation a new chapter also was opened in space conquest.

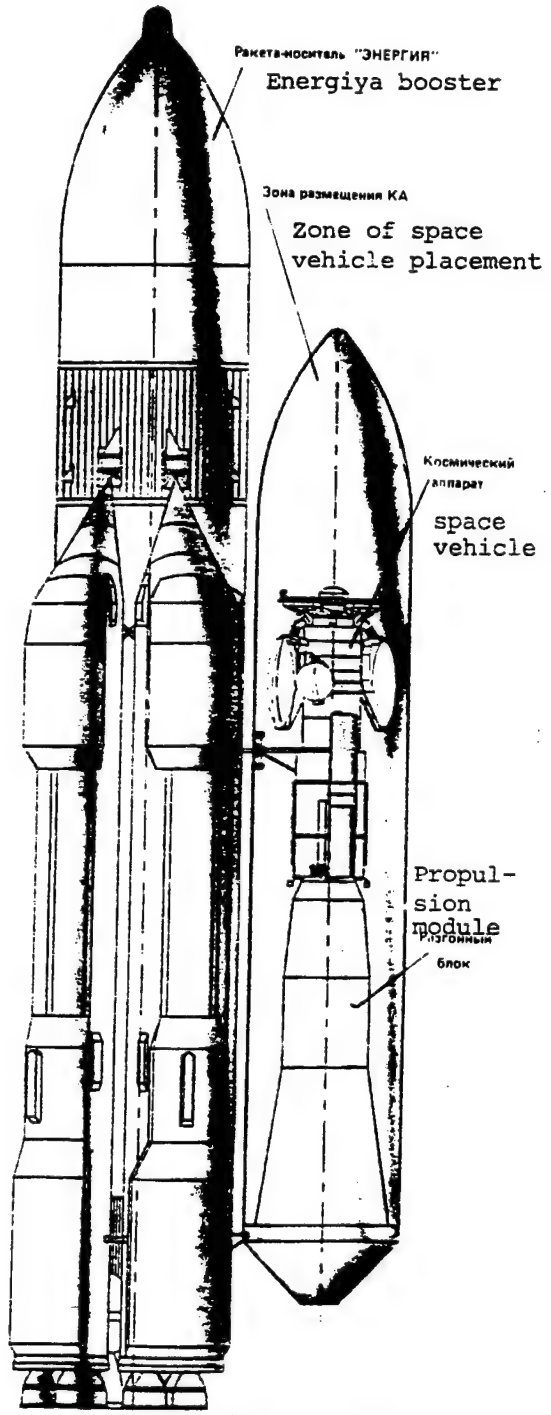
The space era was opened by the first Soviet two-stage booster, named Sputnik, the famous "No 7" developed by Korolev. It put the world's first artificial satellite of our planet into orbit and became the basis for developing the Vostok-Soyuz family of boosters by means of which the first manned space flights were made, which are now continuing.

The heavy Proton multistage booster was put into operation beginning in 1965. It is capable of putting a payload with a mass up to 21 tons into a circumterrestrial orbit. It was supplemented by a space tug (transfer vehicle), the DM oxygen-hydrocarbon module with multiple firing of the engine, providing a powerful means for flights beyond the limits of low circumterrestrial orbits. The possibility appeared for putting into a geostationary orbit a load with a mass up to 2.5 tons, and approximately the same mass onto trajectories for interplanetary flights. The Proton booster delivered into space all the Soviet orbital stations of the Salyut family and the modules of the Mir space system.

Beginning in 1976 development work began in the Soviet Union on a new family of boosters having more perfect operational parameters and a greater lift capacity, operating on ecologically clean fuel components.

Zenit booster. Launching mass—459 tons, mass put into low (H = 200 km) orbit—13.8 tons. Fuel components used—oxygen + hydrocarbon. Rocket height—58 m, diameter—3.9 m.

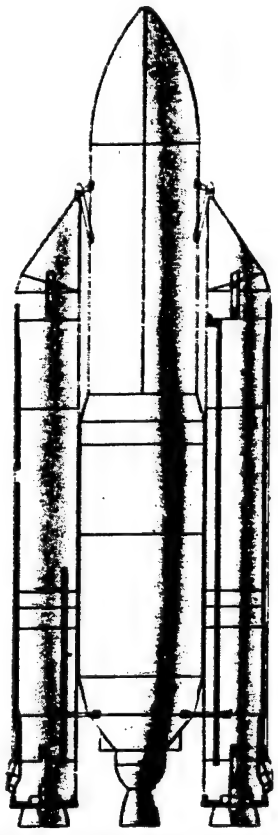
The basis for the development work was standardization principles providing for the use on boosters of different



Buran-T - Energiya booster system with space communication vehicle and propulsion module. System launching mass—2400 tons. Payload mass: in low orbit 98 tons, in geostationary orbit 18-22 tons, on flight trajectory: to Moon—32 tons, to Mars—28 tons, to Jupiter-Sun—7 tons. Rocket dimensions: height—59 m, diameter—16 m. Dimensions of zone of placement of spacecraft: length—22 m, diameter—5.5 m.

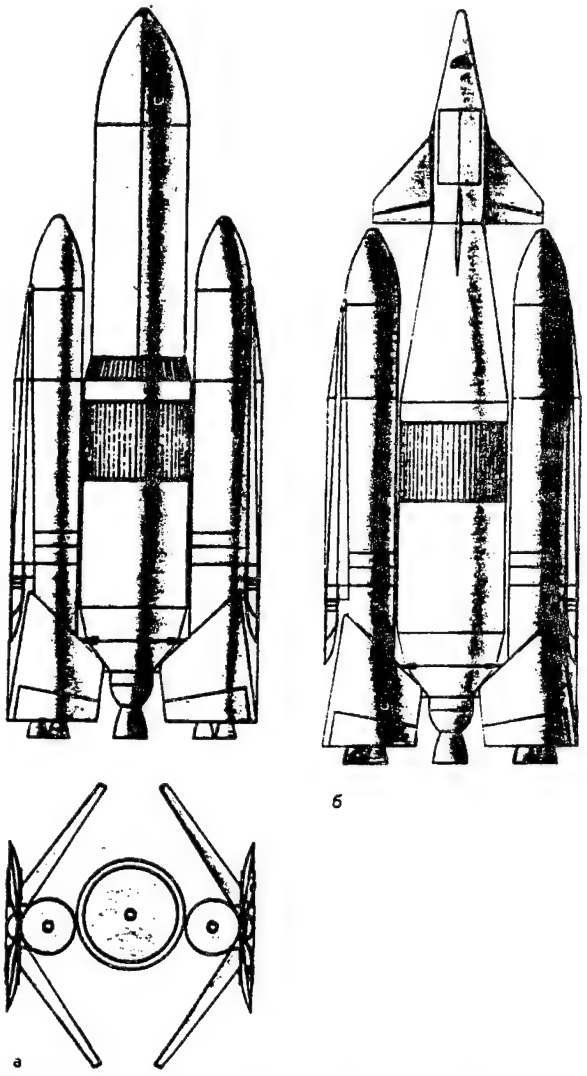
lift capacity of engines of the same type and with an identical design of the first booster stages. There was assurance not only of a decrease in expenditures on development work on rockets and engines, but also an increase in reliability due to the use in the makeup of boosters with a great lift capacity of first stages which had already undergone testing and finalization as components of smaller boosters. Flight tests of the Zenit and Energiya boosters have now been successfully carried out. It is proposed that testing of the Energiya-M booster begin in 1994.

The Zenit booster is a two-stage carrier operating on oxygen-hydrocarbon fuel, ensuring that a payload with a mass up to 13 tons can be put into a low circumterrestrial orbit.



Energiya-M booster. Launching mass—1050 tons, fuel components used: oxygen + hydrocarbon, oxygen + hydrogen. Mass of payloads put into orbit: into low orbit—30 tons, into geostationary orbit—3-6.5 tons (depending on type of propulsion module); on flight trajectory: to Moon—10-11 tons, to Venus and Mars—8-9 tons. Booster dimensions: height—51 m, diameter—16 m. Dimensions of zone of placement of spacecraft: height—15 m, diameter—5.1 m.

When using the DM propulsion module in its makeup, with a launching from the Baykonur cosmodrome, there is assurance that a payload with a mass up to 1.1 ton can be put into a geostationary orbit. The first stage of the



Prospects for development of Energiya-M booster. Use of returnable modules of first stage in principal (a) variant and in variant with small orbital shuttle (b).

Zenit booster has successfully undergone finalization work in the course of its flight tests and has served as a basis for developing the lateral modules of the Energiya.

The Energiya-Buran universal rocket-space transport system uses first stage modules similar to the Zenit and a central module with an engine operating on cryogenic hydrogen and oxygen.

With use of an oxygen-hydrogen propulsion module there will be assurance that a payload with a mass up to 22 tons will be put into a geostationary orbit and a spacecraft with a mass up to 28 tons will be put on a flight trajectory to Mars.

The Energiya-M booster will be operated simultaneously with the Energiya booster and will use the very same launch facilities and surface technical systems. The third stage in the Energiya-M booster makeup may be, depending on the objectives, the DM propulsion module or its modification with an increased fuel supply, held in suspended jettisonable fuel tanks. It also is proposed that use be made of an oxygen-hydrogen transfer vehicle. The Energiya booster can put into a low circumterrestrial orbit payloads with a mass up to 35 tons and into a geostationary orbit—up to 5.5 tons with use of a modified oxygen- hydrocarbon propulsion module and up to 6.5 tons with use of an oxygen- hydrogen module.

The simultaneous use of the Zenit, Energiya and Energiya-M boosters, consisting of standardized components, will ensure a high reliability of the rocket-space systems.

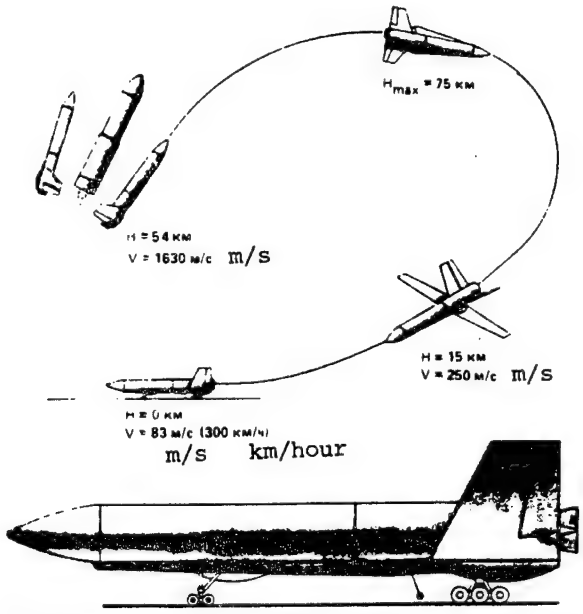


Diagram of use of returnable modules of first stage of Energiya-M booster. Landing mass—68 tons. Maximum distance from launching point—320 km.

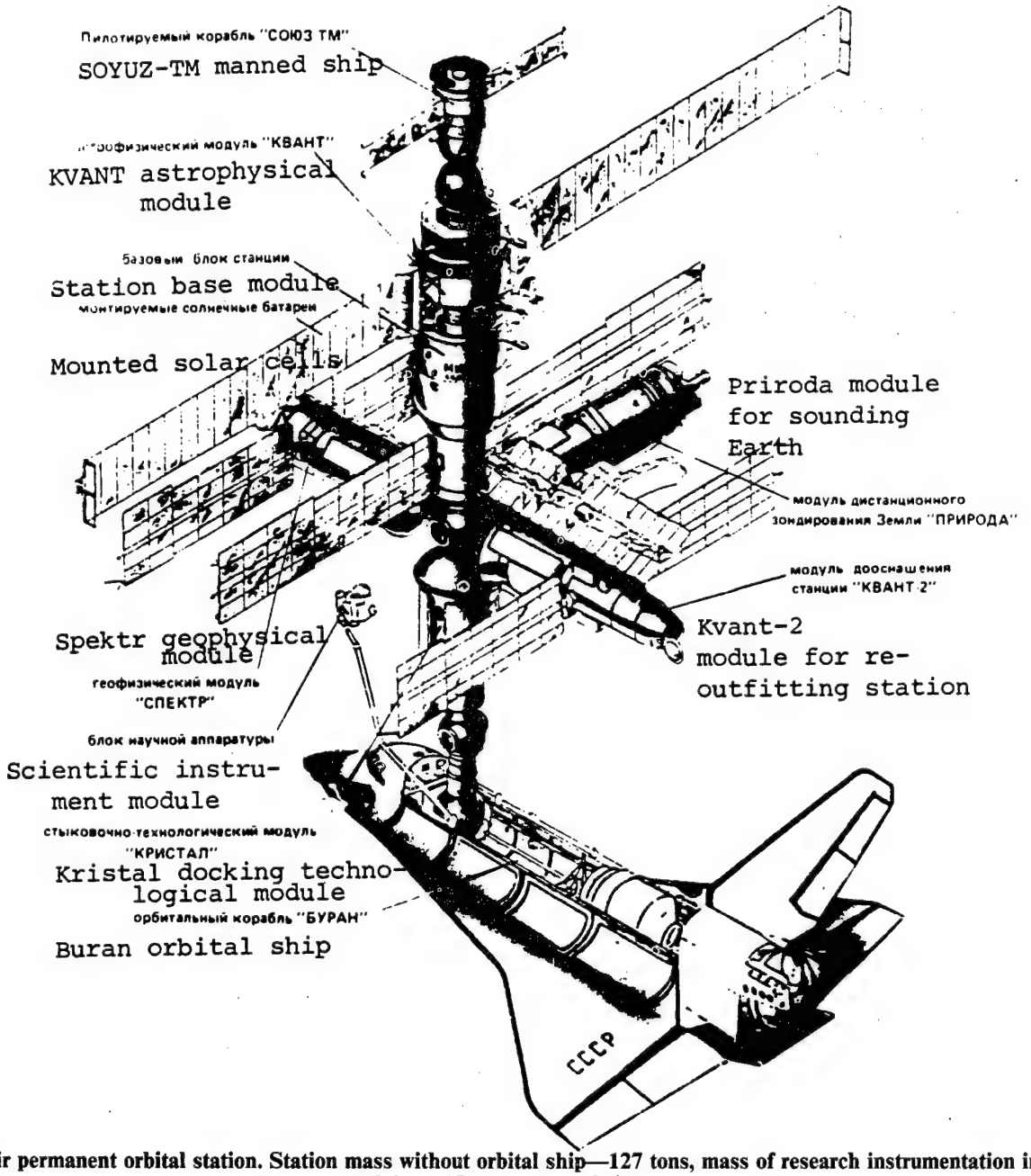
As one of the possible directions in further reduction of the area of alienated lands in the regions of falling of parts of the first stage and reduction in the cost of boosters development work is being carried out on a booster variant with recoverable first-stage modules. These will be unmanned stratospheric gliders automatically returning to the launch site.

Orbital Manned Space Systems

In Soviet cosmonautics the key task has been the development and improvement of orbital space systems. Such systems for many years have already been operating in orbit and have progressed from a visited station to a permanently operating multimodule structure. Various

kinds of space activity have been mastered in them: from the implementation of the most different kinds of scientific and technical research projects to highly complex assembly-construction work, including with rotatable construction components.

The principal feature of our orbital stations is universality, the possibility of carrying out various kinds of research work aboard them. Along individual lines results have been attained at the level of scientific discoveries, such as observations of the supernova in the Large Magellanic Cloud. The techniques for prolonged flights and man's work under weightlessness conditions have now been mastered and problems in postflight therapy have been solved.



Mir permanent orbital station. Station mass without orbital ship—127 tons, mass of research instrumentation in modules—15 tons, crew—2-6 men.

Special attention is being devoted to development work yielding an economic advantage to the country. This includes production of highly effective pharmaceuticals and semiconductor materials, monitoring and investigating the Earth's surface for the purpose of studying natural resources, mapping of the Earth and solution of ecological problems (ZEMLYA I VSELENNAYA, No 2, p 33, No 5, p 34, 1988; No 4, p 3, 1989—Editor's note].

Work in the bioengineering field is promising. The technology for the production of highly active interferon, insulin, free of impurities, and other drugs for the treatment and prevention of such severe and dangerous illnesses as hepatitis, radiation diseases, diabetes and others, has been mastered aboard the Mir station.

Several consignments of semiconductors fabricated in orbit also have been used on the Earth for carrying out research in the field of space materials science and in instrument making.

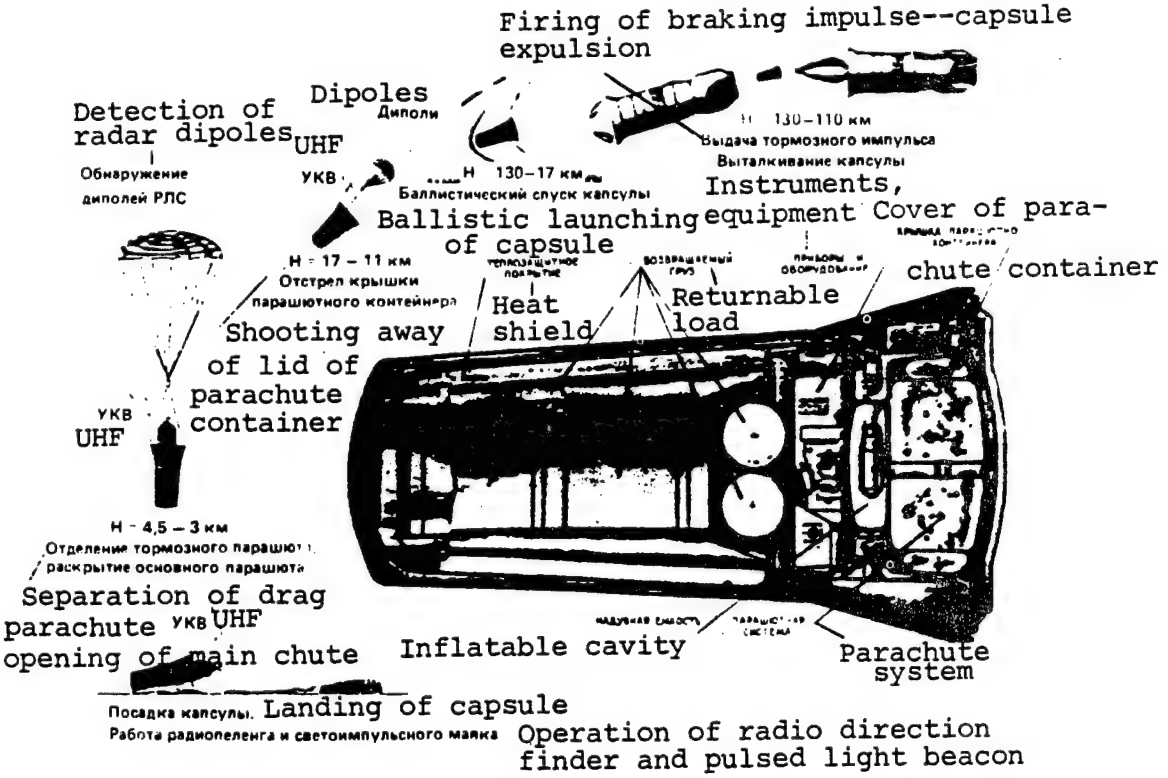
Photographs of the Earth's surface can be routinely returned from space by ballistic capsules. In our country alone this information is being used by more than 1100 enterprises. Soviet space photographs also have entered the world market. With respect to a number of indices they are considerably superior to foreign photographs. About 80 foreign partners are users of our space photoinformation, among them organizations in the United States, Japan, European countries and China.

Energiya-Buran Space System

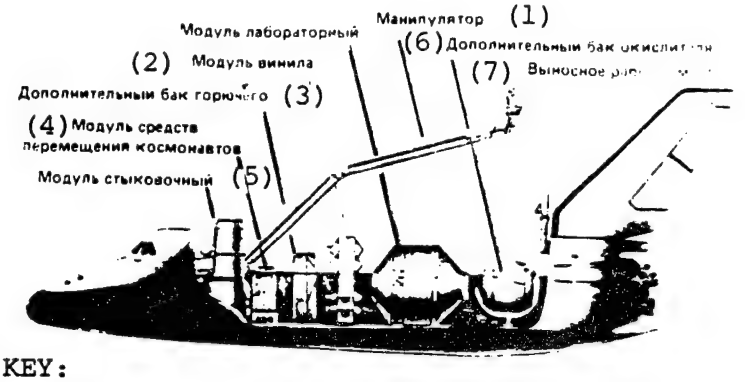
The flight of the Energiya-Buran space system laid the beginning of a new stage in Soviet cosmonautics. A universal rocket-space system was developed which is capable of solving a wide range of scientific and economic problems.

The Energiya-Buran system (ZEMLYA I VSELENNAYA, No 2, p 3, 1989—Editor's note), in contrast to the American Space Shuttle, is in its structure actually a universal rocket-space system capable of launching not only the Buran orbital ship, but also, in the Buran-T modification, a payload with a mass up to 102 tons. The range of its applicability is extremely broad: from putting the orbital ship Buran and the modules of orbital stations into low orbits to technical support for flights to the Moon and Mars.

A unique component of the system is the Buran orbital ship, making it possible to solve such new problems as the implementation of transport- technical servicing of orbital systems and space vehicles, assembly of large structures, return of multiply usable modules of orbital stations and items of industrial production to Earth, putting into orbit expensive space apparatus requiring checking of its condition prior to transfer into a self-contained functioning mode or its delivery to an orbital station.



Returnable ballistic capsule. Developed for routine return of necessary loads from Orbit. Capsule mass—350 kg. Mass of returnable load—up to 150 kg. Capsule length—147 cm, diameter 78 cm.



KEY:

1. Manipulator
2. Vinyl module
3. Supplementary fuel tank
4. Module of equipment for movement of cosmonauts
5. Docking module
6. Supplementary oxidant tank
7. Extensible work station

Outfitting of Buran orbital ship.

For all these purposes the Buran ship is outfitted with an on-board system for servicing payloads, a remote manipulator, transfer, docking and locking compartments and much else.

An objective of upcoming Buran flights is interaction with the Mir system: when making a second unmanned flight there is to be a docking with the Mir system, testing of the on-board manipulator with transfer of a special module to the station and return of a solar cell to the Earth. The objective of the manned launching is lengthening of the active lifetime of the Mir system by means of delivery of a new base module and restructuring of the system using earlier launched modules. This can be done only by using the Buran ship.

Future of Communications: Space Platforms

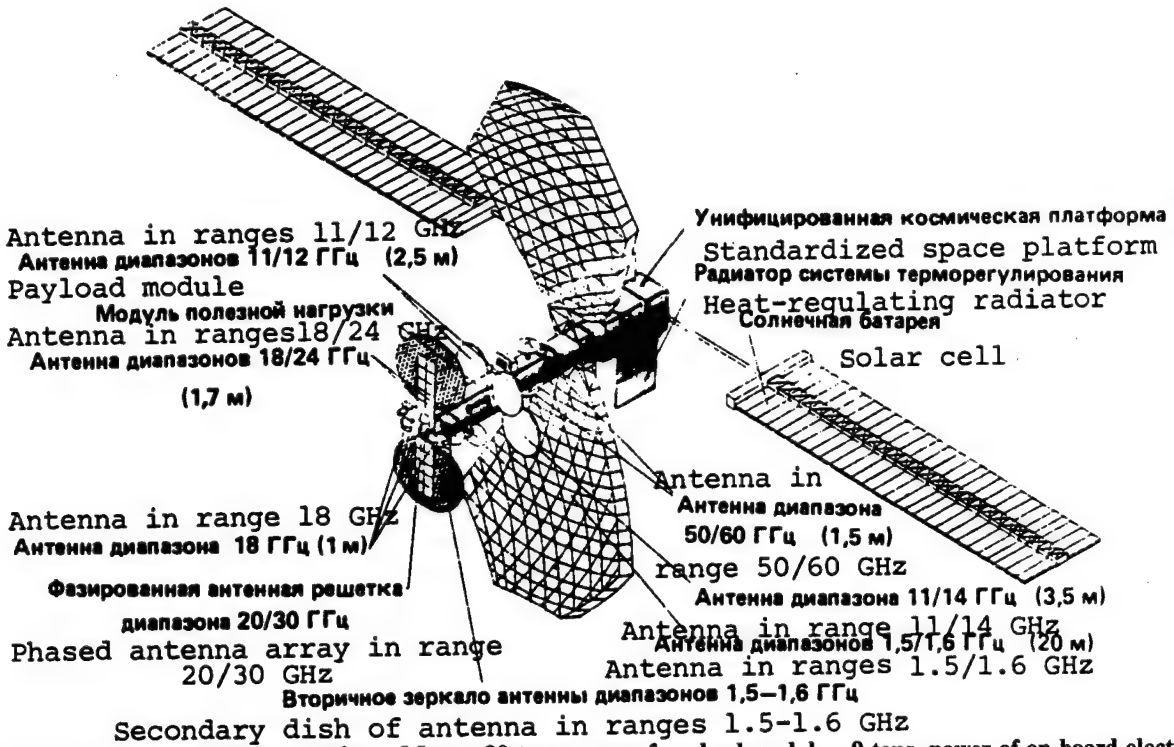
The need of society throughout the world for information is constantly growing and this growth is occurring exponentially. Even today there is a need for multitudes of channels at the high-clarity television level.

The shortest way to solve this problem is an increase in transmission power, sensitivity of reception and information capacity of the channels of space communication systems.

On space platforms we will have a possibility for placement of a powerful power supply system, any necessary number of repeaters and antennas with a large aperture, and accordingly, with narrow directivity, We can cover the necessary area of the Earth's surface with a grid of narrow rays. Then for reception and transmission at each point in this grid it is not necessary to have very complex user equipment. A commutation matrix of on-board repeaters is provided for on the platform between points in any combination in order for the multiray system to operate as a single broad ray.

In this way communication over a very great territory is ensured at a qualitatively new level, with the greatest possible miniaturization of surface equipment for individual communication. When using a large number of narrow rays it is possible to make multiple use of the very same radio frequencies due to spatial separation of the rays and therefore a large platform will make possible a sharp increase in the total number of communication channels.

By ensuring a great carrying capacity a single large space vehicle, in handling the very same tasks, will be able to replace several communication satellites and this will represent an economy in regions where there is already a shortage of space, in geostationary orbit, of which our planet has only one, and which even now is overloaded, and taking into account the Earth's limited resources, must be dealt with carefully. In order that in the course of operation neighboring satellites do not create interference with one another and that surface stations, in making contact with "their" satellite do not intercept the radio ray of some other satellite, the distance between them in the celestial sphere must be not less than 1°. This means that not more than 360 satellites can be actively functioning simultaneously in geostationary orbit. For the time being their number is close to half the limit, but the situation is being complicated by the great number of nonoperating satellites and parts of boosters.



Large space communication platform. Mass—20 tons, mass of payload module—9 tons, power of on-board electric power plant: total—24 kW, allocated to payload module—20 kW; accuracy in orienting on-board antennas is 0.1°, accuracy in maintaining position in orbit is 0.1°, lifetime is 10 years. The diameters of the antennas are given in parentheses.

Accordingly, the day is probably not far off when we must solve the problem of how to clean up the geostationary orbit and how to make new satellites in such a way that when their missions are completed it will be possible to eliminate them from this orbit using their own engines or by the installation of special docking assemblies to which automatic tugs—"trash collectors"—could be docked. Only sufficiently large space vehicles can be outfitted with such docking elements.

This does not mean, to be sure, that today all world communication must urgently be "switched" to large communication platforms. There are still regions in which it is desirable to use small communication satellites, but the future unquestionably belongs to satellite systems based on large platforms. Mankind is impatient: even today it has need for those capabilities which large platforms promise to afford. They can be used in establishing a new worldwide information and cultural medium which in turn will give rise to a qualitatively new situation in world culture.

It must be noted, in particular, that the Soviet Union has a number of special characteristics giving it advantages in the use of such powerful communication facilities. Most importantly, the capability for putting 20-ton communication platforms into a stationary orbit using the Energiya booster.

Global Space Ecological Monitoring System

The consequences of such catastrophes, as, in particular, pollution of the world ocean and atmosphere and, as a result, unpredictable climatic changes, are of a planetary scale and place before mankind the general problem of survival.

The aggravation of ecological problems and the increasing scales of environmental pollution caused by the uncontrolled anthropogenic impact on the environment and natural calamities, exhaustion of renewable and nonrenewable natural resources, led to an awareness of the need for setting up an information system for monitoring ecological conditions, use of the environment and warning of natural calamities and extraordinary situations. Such a system would help in realizing a regulable feedback between the environment and society and would provide a basis for formulating a strategy for individual regions.

Accordingly, without question, in the immediate future a unified international system will be established for monitoring the ecological situation and environmental use, monitoring and warning of extraordinary situations, a component part of which will be a space monitoring subsystem.

Our country could make a major contribution to the organization of a unified system, especially the space part of the system.

Space vehicles for operation in a low circumterrestrial and in a geostationary orbit are being designed for such a system at the Energiya Scientific Production Association.

Such space vehicles are being constructed on the basis of "heavy" and "intermediate" standardized space platforms respectively, one of whose prototypes is the Gamma astrophysical research module, now in orbit.

Only space observations will ensure on-line collection of information on the environment from extensive territories of the Earth, which will make it possible to investigate the spatial distribution of parameters of ecosystems.

Only space observations will ensure simultaneous registry of a broad spectrum of environmental parameters, making it possible to study transpiring processes in their interrelationship.

Only space observations can ensure repeated and on-line registry of various environmental parameters at definite time intervals.

Flight to Mars

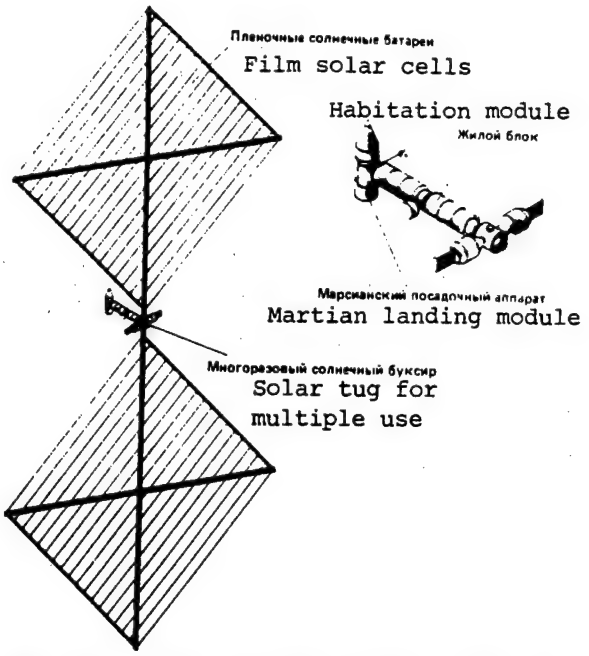
The matter of sending a manned expedition to Mars is now being actively debated at all levels. But in addition to arguments on the economic and scientific feasibility of the project, in the discussions a place of more than a little importance is occupied by the technical aspects of the flight, which will play a significant role in making a final decision. That is why projects for Martian ships and other assemblies which will be used in the expedition are now being worked out and made more detailed.

Two principles must be taken into account in working through the idea of a Martian expedition:—the execution of the expedition must not be a "one-time go" and in the course of ship preparation economical space transport ships must be constructed which also could be used in other programs;—the Martian program must be as cheap as possible and have a high level of reliability and crew safety.

Proceeding on the basis of these principles, we are now giving preference to a variant based on use for interplanetary flight of the most economical type of engine existing in nature: an electrojet engine. The electricity for such engines is provided by film solar cells.

A Martian ship will consist of three principal parts: habitation compartment, vehicle for landing on the surface and a solar "tug."

It is assumed that the initial mass of the ship system will be 350 tons, including: habitation module—80 tons, landing vehicle 60 tons, vehicle for return to the Earth—10 tons. The solar tug, to which two panels of solar cells will be attached, will have a mass of 40 tons and the fuel



This may be what a Martian ship will look like. The initial mass of the space system is 350 tons, including: habitation module—80 tons, landing module—60 tons, vehicle for return to Earth—10 tons, solar tug—40 tons, fuel—160 tons. Dimensions of one solar cell: 200 x 200 m. Number of crew members: 4. Total duration of expedition: 720 days. Time for crew to remain on Martian surface: seven days.

will weigh 160 tons. Each of the panels will measure 200 x 200 m. The crew of four men will be on the Martian surface for seven days and the total duration of the expedition will be 720 days.

Already much has been done which is suitable for preparation for the first interplanetary flight: the Energiya booster, capable of putting a part of a Martian ship into circumterrestrial orbit, has been developed, an automatic docking system for its assembly has been finished and important experience has been accumulated with prolonged flight in space. There are no special problems in developing the ship's habitation module: experience in constructing orbital stations and their systems in this sense is very important. Significant successes have been attained in constructing electrojet engines: even today their characteristics are acceptable for a Martian ship.

On orbital stations much work is being done on the finalizing of rotatable beam construction components which will be used for the ship's film solar cells.

At the present time both we and the Americans are already technically ready to begin independent work on organization of the first interplanetary flight. But the first flight to Mars is in essence a matter of concern to all

mankind and in addition, is a very expensive measure. Accordingly, without question the entire world community must participate in the organization of this expedition.

Concise Summary

The priority objectives are constant observation of objects in the universe in all spectral ranges, global ecological monitoring and universal telephone communication. There is no need to postpone manned flights to solar system planets. It is necessary to make a serious investigation of the possibility of using reflected sunlight for the illumination of polar cities, discharge of ecologically dangerous products beyond the limits of the biosphere, construction of orbital solar electric power plants for producing power without the combustion of fuel and other unfavorable impacts on the environment.

The timeliness of these global problems, of interest to all mankind, under the present conditions should unquestionably find a place in interrepublic agreements on the continuation of work on the mastery and exploitation of space, as well as on the broadening of international cooperation.

Transport System for Lunar Base

927Q0107 Moscow ZEMLYA I VSELENNAYA in Russian No 5, Sep-Oct 91 pp 19-25

[Article by B. I Sotnikov, candidate of technical sciences; and G. I. Baydal and G. A. Sizentsev, engineers; NPO Energiya]

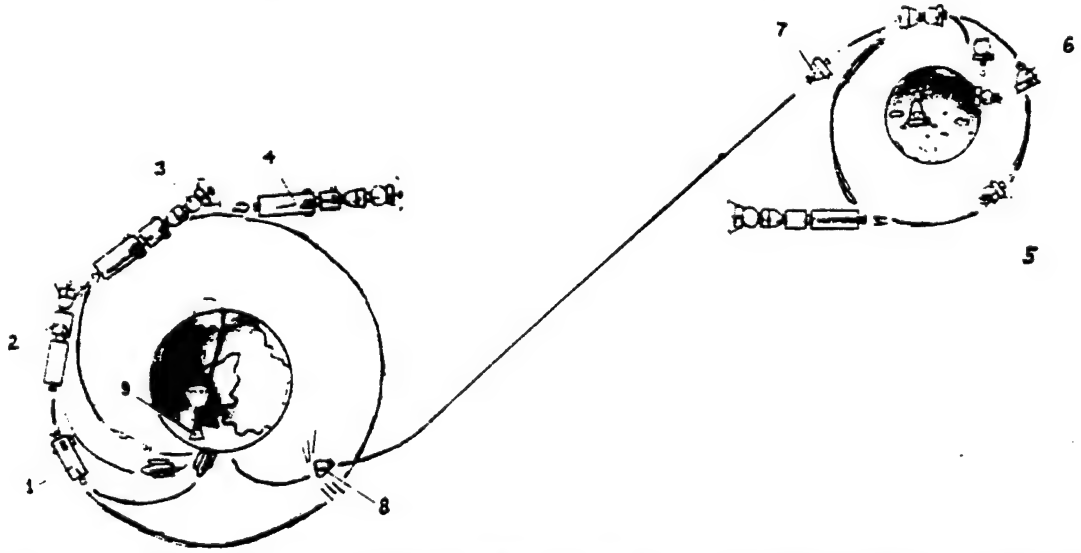
[Text] A science conference focusing on the matter of creating a permanent based on the Moon as an initial stage in the exploitation of Earth's satellite was held 5-8 February 1991, at the P. K. Shternberg State Astronomy Institute of the Moscow State University (MGU). Preliminary forecasts by specialists place the realistic possibilities for execution of such a project at no earlier than the first half of the next century. In addition, the complex nature of the task and the far-reaching consequences of its execution require a complex, thoughtful scientific-technical assessment. Since state space programs have yet to provide for solutions to any specific aspects of the problem that are associated with the exploitation of the Moon, a large group of specialists from various fields have taken it upon themselves to conduct preliminary studies. The Solar System Section and the Moon and Mercury Working Group of the USSR Academy of Sciences Astronomy Council were the organizers of the conference. The running of the conference was charged to MGU's P. K. Shternberg State Astronomy Institute, where successful work in the lunar field—which also includes a study of the problem of extraterrestrial natural resources—is being done.The conference consisted of four thematic sessions.The theme of the first session—"General Aspects of the Prospects of Creating a Habitable Base on the Moon"—combined papers of a conceptual nature.The second session was devoted to the theme of "Technical Possibilities of the Exploitation of the Moon."The papers of the third session were combined under the theme of "Scientific Problems Associated With Choosing a Site for the Lunar Base and Predicting the Location of Natural Resources."The fourth session was devoted to the them of "Scientific Research Programs at the Lunar Base."More than 70 specialists from 20 science and scientific-production organizations of the USSR took part in the work of the conference. A total of 35 papers and brief communications were read, and there was a general discussion of the topics cited above.With the publication of this article by B. I. Sotnikov, G. M. Baydal, and G. A. Sizentsev and an article titled "Planet Rovers" [see p. 75 of this issue], the journal is beginning a series of articles devoted to the problems that were discussed at the conference.One way of solving some of the global problems facing mankind, such as depletion of resources and the impending ecological disaster, is to use extraterrestrial resources and to take some of our industry into space. In that regard, the Moon is an attractive site in that it is man's nearest natural outpost in space. Of course, making the transition to the exploitation of the Moon's resources is impossible without a serious study of the Moon and the solution of a number of fundamental problems. Those problems involve the long-term stay of man in specific extreme conditions, the exploration of the lunar interior, raw materials refining, the creation of a production base, and the development of mechanisms for transporting finished product (energy, raw materials, intermediate products-to Earth and to near-Earth facilities.At present, questions associated with the creation of a base on the Moon are being vigorously discussed and studied in many countries of the world at numerous symposia and conferences and in the scientific-technical literature. It is obvious that, without first developing the Moon, the continuation of mankind's vigorous advance into space is unthinkable, as are the acquisition of new knowledge and the discovery of raw material sources. The United States, it should be noted, is showing especial interest in the Moon. Speaking to graduates of an American university, U.S. President G. Bush declared this: "An international space station, a lunar base, and a manned mission to Mars are the cornerstones of the long-term plan of my administration to invest in the future of America."A lunar base is taken to mean a complex of systems enabling personnel to live and work, on a temporary or a permanent basis, on the Moon, with the deployment of an infrastructure, the replenishment of expended materials, and the growth of functional capabilities.

How Do We Get to the Moon?

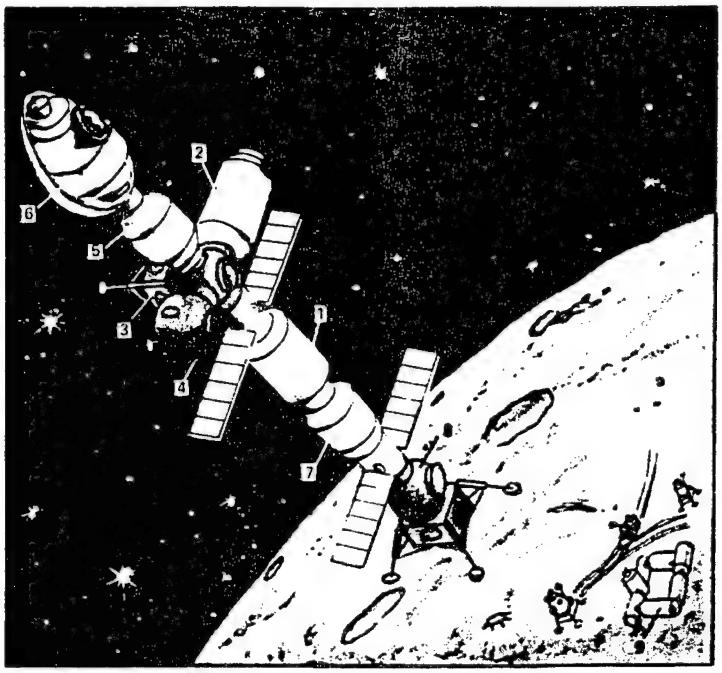
Consideration of the creation of a lunar base is pointless without consideration of a **delivery system.** Such a system

constitutes one of the chief engineering problems to be addressed, because the main components for the deployment of the base's infrastructure (living quarters and research and production structures), plus all that is necessary for man's activity on the Moon, must initially come from Earth. Let's try and look at the possibility of creating such a transportation system on the basis of the hardware existing in our country at this time.The main component of the transportation is the **launch vehicle.** At present, the USSR has a number of launchers, the most powerful of which—the **Energiya**—can place a payload of 100 tons into near-Earth orbit. The heavy-lift Energiya launcher can be used to create launchers of a heavier class (**superheavy-lift**) or of a lighter class (**medium-lift**). Superheavy-lift launchers are expected to be used for delivering especially heavy or large nonseparable cargoes. Launchers of the medium-lift class can be used for carrying supplies to the base personnel or for building the base's infrastructure.Both the foreign and the domestic technical literature have alluded to a good many projects and profiles for the construction of lunar bases and for the deployment of systems serving such bases. Specifically, the well-known project advanced in the early 1970s by North American Rockwell called for the use of the expendable systems used in the Apollo project. In 1984, the Johnson [Space] Center presented a profile that used reusable systems based on the Space Shuttle system. A 1985 publication by the U.S. National Academy of Sciences —"Lunar Bases and Space Activity in the 21st Century"—submitted an advanced profile for the construction of a lunar base and the build-up of its activity, based on future hardware systems. Research materials developed by NASA's Division of Astronautics and Space Technology also call for the use of reusable systems.In-depth studies have also been done in our country. Let's examine **two profiles** for the construction of a lunar complex: a traditional profile based on the use of expendable hardware, and an **advanced** profile that uses reusable hardware.The first profile —for a base prototype/outpost in a selected region of the Moon —calls for construction that uses expendable systems.

The base, in its simplest form, must include a **lunar living module** that supports active, long-duration functioning of personnel on the Moon and a **lunar ascent/descent craft** that functions as a transportation system on the segment between the Moon and artificial lunar satellite orbit. An intermediate link in the chain is needed—a towcraft between artificial Earth satellite orbit and artificial lunar satellite orbit. Both delivery systems are can be used in manned or cargo versions; in the manned version, the lunar complex is outfitted with an **Earth-return vehicle** (i.e., a crew cabin on all segments of the transfer). The part of the towcraft that effects the boost of the return vehicle to Earth stays in circumlunar orbit, waiting for the ascent craft.Based on that profile, one can imagine the following process for the deployment of a lunar base. Components of the lunar complex—the **towcraft** (the boost/retrorocket unit), the lunar living module, and the lunar lander—are placed into artificial Earth satellite orbit in pieces with the first two launches of the Energiya booster. The components of the complex are then linked, and the package is boosted to the Moon. The complex decelerates near the Moon, and the lunar lander and the lunar living module separate [from the towcraft] and land on the Moon.In our opinion, the **next two launches** of the Energiya booster into artificial Earth satellite orbit should lift, in pieces, a manned lunar complex/towcraft consisting of a boost/retrorocket unit for the flight to the Moon and a boost unit for the return



Profile for the construction of a lunar base with expendable systems: 1 —boost/retrorocket unit; 2—booster; 3—lunar ascent/descent craft; 4—lunar package at translunar injection; 5—descent of lunar lander from circumlunar orbit just before landing on the Moon; 6—lunar orbiter; 7—trans-Earth injection of return vehicle; 8—reentry of return vehicle into Earth's atmosphere; 9—descent module at landing



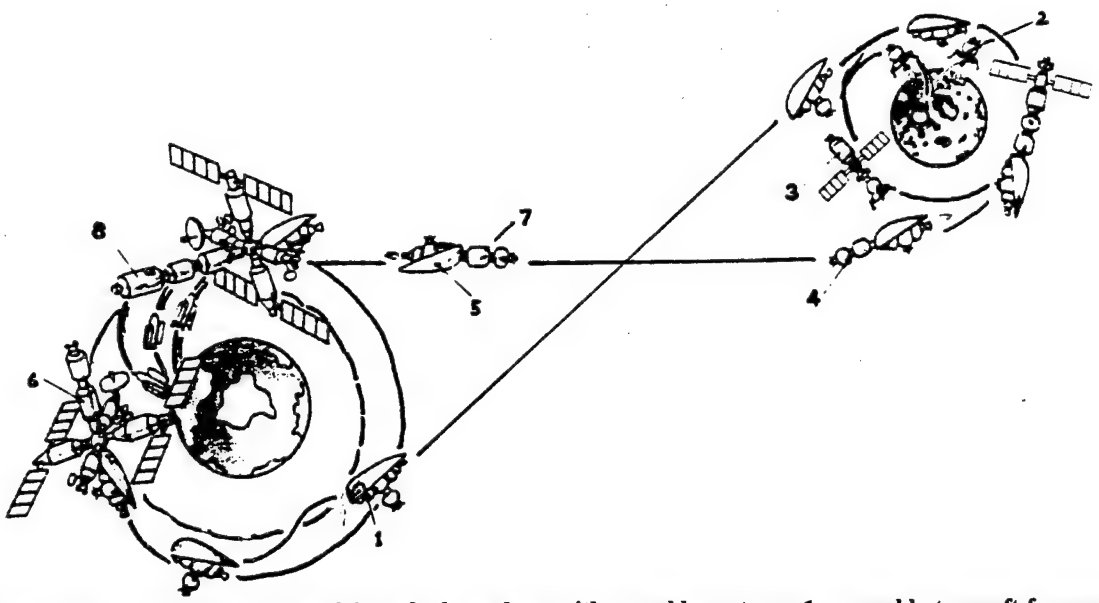
Lunar orbital station: 1—base module of lunar orbital station; 2—fuel module; 3—chassis of reusable lunar landing stage; 4—crew cabin; 5—cargo container; 6—reusable towcraft; 7—orbital science module; 8—lunar excursion module; 9—base modules

to Earth and a lunar lander without a return vehicle. The components are docked in orbit. A **fifth launch** (with a Zenit booster) puts into artificial Earth orbit the return vehicle with a crew of three people. The return vehicle docks with the package already in orbit and is boosted to the Moon and delivered to circumlunar orbit. After separating from the orbiter, the crew lands on the Moon near the lunar living module. The crew begins performing the scientific research program. It will have at its disposal an open-type lunar rover.

Without additional supplies from Earth, personnel can work at the base for three months; crew members are replaced once a year. Expendable materials are delivered by boosters of the medium-lift class; resupply is done with the Energiya boosters. After that, the base is built-up and improved. The base's systems and structural elements and the principles of development of the infrastructure are then refined as the base functions.

But Will We Be, Perhaps, Careful Proprietors?

One can also imagine an **alternative version** for solving the problem, one in which **reusable systems, combined with expendable or partially reusable boosters,** are used to construct the lunar base.Unlike the first version, in which the components of the system for ferrying cargoes and crew to the Moon and back are used without recovery, this version uses expendable boosters to lift just the heavy structural units (the towcraft, the lunar complex craft, the base modules, the fuel) or the cargoes that do not require additional servicing. All that (except the fuel) is dispatched to the Moon by, as a rule, a boost unit of the same launch. The reusable systems are used on the individual segments of the Earth-Moon flight trajectory. The Energiya booster and the reusable Buran space system are used on the segment between Earth and artificial Earth satellite orbit. The segment between artificial Earth satellite orbit and artificial lunar satellite orbit uses a reusable towcraft fueled in near-Earth orbit by a tanker/booster. The segment between circumlunar orbit and the Moon uses a reusable ascent/descent stage.We suggest building the towcraft with a profile that uses aerodynamic braking in the atmosphere (the vehicle must have an aerodynamic braking shield). In the manned version of the towcraft, the crew cabin transfers from the towcraft to the lunar lander, and back, by means of docking. When the reusable towcraft is about to reenter near-Earth orbit, a tanker is launched to an area near it. The tanker docks with the towcraft and pumps fuel on board. Then the Buran lifts off, carrying base components, cargoes, and crew into near-Earth orbit. It docks with the fueled towcraft, the complex is assembled with the orbital craft's onboard manipulators, and the crew makes its transfer. Then the complex begins translunar injection. As it draws near the Moon, the complex brakes and goes into circumlunar orbit. At that point, a reusable lunar craft lifts off from the Moon's surface and enters circumlunar orbit, docking with the complex. After docking, the lunar craft takes on fuel from the towcraft and takes on cargo and crew and delivers them to the Moon's surface.



Profile for the construction and servicing of a lunar base with reusable systems: 1—reusable towcraft for segment between artificial Earth satellite orbit and artificial lunar satellite orbit; 2—reusable lunar ascent/descent stage; 3—lunar orbital station; 4—crew cabin; 5—lunar complex at translunar injection; 6—long-duration orbital station near Earth; 7—cargo container; 8—tanker/refueler

Rendezvous at a Space Mooring

In that profile, the dates for launches and dockings are rather rigidly linked to each other. The profile can be made more flexible if the services of an orbital complex in near-Earth orbit are used and if an **orbital station in circumlunar orbit** is built. Then the dates for arrivals, dockings, and departures could be "untied" from each other in terms of time, each component would have a large degree of independence, and the reliability and safety of the execution of the job would be raised.

The experience garnered in the operation and servicing of the Salyut-series stations and the Mir complex yields a virtually ready-for-use model of a near-Moon station. All that is needed is a launch of the Energiya vehicle with a boost unit and the station.The orbital complexes enable the following: storage of fuel and cargoes; flexible, more efficient cargo flow; expanded geography in terms of the points of siting of the base components; study of the Moon and lunar resources; early replacement or emergency evacuation of crew; optimized, in-orbit production; return cargo flow (back to Earth-involving only intermediate or finished products. Specifically, that could involve the fuel component, liquid oxygen.If the cargo flow to the Moon and back goes through a near-Earth orbital complex, then the delivery to that complex of crew, valuable cargoes, or complicated hardware components that require checking, assembly, and adjustment before translunar injection can be done with the Buran vehicle.What would be sequence be in deploying such a system? Reusable systems would be placed on line in a stages. First it would be advisable to put a reusable towcraft on line and to use the lunar lander (which would be expendable in the first cycle) to deliver a living module to the Moon.The **first two** launches of the Energiya would lift into near-Earth orbit the components of the lunar complex —the towcraft, the lunar living module, and the fuel for the towcraft's cycle of operation. The components would then dock, and the rest of the fuel would be pumped from the tanker to the towcraft. A **third launch,** with the reusable Buran, would lift the unfueled lunar lander (an expendable unit). The lander would dock with the complex and take on fuel from the towcraft. Translunar injection would then take place. Near the Moon, the towcraft would brake the complex, and the living module would be delivered to the surface by the expendable lunar lander. The reusable towcraft would return to Earth. The mass of the living module on the Moon would be roughly 15,000 kg, which includes about 5,500 kg of scientific-research equipment.Then the reusable lunar lander would be put on line, and it would deliver the crew to the Moon's surface. For that, the **next two launches** of the Energiya would put fuel into near-Earth orbit, for fueling the reusable towcraft for the entire cycle of operations, as well as the crew cabin. The towcraft would dock with the tankers, take on fuel, and then dock with the cabin. In a **sixth launch,** Buran would lift the reusable lunar lander and deliver the crew to the complex. It would dock with the complex, the lunar lander would take on fuel from the towcraft, and the crew would transfer to the complex. The complex would begin translunar injection. The towcraft, after braking the complex near the Moon, would return to Earth. The reusable lunar lander would deliver the crew to the surface in the vicinity of the landing site for the living module. The base would begin

functioning.The lunar orbital complex would be put on line in the next stage of operations. The principal task in that period would be to deliver the station, with crew, to circumlunar orbit. In a **seventh launch,** the Energiya booster would take fuel into near-Earth orbit for the reusable towcraft. The towcraft would dock with the tanker and take on fuel. In the **next launch,** a medium-lift booster would be used to place the lunar orbital station and the rest of the fuel for the towcraft cycle into near-Earth orbit. Docking would take place, and fuel would be pumped to the towcraft. After that, a **ninth launch** would involve Buran, which would the crew to the complex. After crew transfer, the complex would begin translunar injection. The towcraft would deliver the lunar orbital complex into circumlunar orbit and would then return to Earth, docking with a near-Earth complex. The lunar orbital station would begin operations. The initial mass of the near-Moon station would be about 20 tons.Thus, the entire system of hardware would be on line after the completion of that series of launches. Then comes the stage involving routine supply of the lunar base and the lunar orbital station (which is done through the near-Earth complex). Cargoes and fuel are delivered to the Moon's surface and to circumlunar orbit, and personnel are replaced.For the system's operation, the necessary reserves of fuel are delivered to the near-Earth complex by active tankers. Each cycle of supply of the lunar base requires two tankers of fuel, i.e., two launches of Energiya are needed. The delivery of crew, cargoes, and the remaining complement of fuel to the near-Earth complex is best done with the reusable Buran system. After docking, the complex is fueled up, the crew transfers, and the cargoes are transferred. The complex begins translunar injection (in the sequence explained above). Cargoes and crew are delivered to their designated destinations (circumlunar orbit or the surface). And the cycle is repeated.The reusable system can begin to function optimally on the segment between artificial lunar satellite orbit and the lunar surface only after appropriate fuel reserves exist on the surface and in circumlunar orbit (fuel components will have to be produced on the Moon). The change-over to the fueling with oxidizer on the lunar surface (if liquid oxygen is produced at the lunar base) will enable an increase in the mass of the payload delivered to the Moon, to roughly 12,300 kg. And if the production of the second fuel component (propellant) is set up, then the payload figure rises to 15,500 kg.Other profiles for deploying a lunar base could certainly be proposed. But let's compare the profiles that we've just examined. The first profile is good in that most of the hardware that it uses has already been studied in rather fine detail. It uses systems that have been tested to date, and the number of launches it would take to get the base functioning would be minimal (which affords something of a time advantage in the initial stage). The prototype of the base would being operation after four launches of the Energiya booster and one launch of the Zenit booster. The profile does, however, have a substantial drawback: all the hardware, at any of the stages of flight, is unrecoverable. Such an approach can hardly be considered satisfactory.The **second profile** proposes a more complex, but advantageous route. It is based on the use of reusable hardware that goes through the stages of the cycle on a regular basis and makes it possible to handle the task at hand with a minimum of expense. And although we don't achieve the same quality as the first profile until a little later (a very simple lunar base begins its operation after four Energiya launches and two launches of the reusable Buran), we do get, unlike in the first, a long-term system. Losses of its components will be kept to a minimum (specifically, the tanker/refuelers can be brought back to Earth by the Buran orbiter). Subsequent launches for the creation of a lunar orbital station make the profile more flexible and stronger. For all its pluses, however, it does require designs that are more complex. Among the drawbacks of the first profile are that it complicates operations in space and on Earth and involves forced losses of payload mass. The profile necessitates paired launches of heavy-lift boosters (very close in terms of astronomical time intervals), because cryogenic fuel components can not be stored in open space for a long time. Numerous dockings are unavoidable, as are the corresponding losses of payload mass (for manned complexes, there are at least two dockings). The reliability associated with the handling of the task is also lowered, because of mandatory separation of hardware and the introduction of additional systems and manipulations in space. Those drawbacks are partially true of the second profile. It's true that a superheavy-lift booster could be created and that the entire lunar complex could be placed on it—i.e., we could move to a single-launch version. If the first profile were used, then the lunar base could begin functioning as early as after the first two launches.

What's the Cost?

The cost of operating the equipment with the paired launches is higher than with the single-launch version. For example, the cost of one launch of a superheavy-lift booster based on the Energiya rocket would be 100 million rubles (R). Thus, nearly R200 million would have to be spent on launches before the lunar base could begin operating. The total cost of the launches for deploying the base in the first profile would be R330 million.At the same time, however, the creation of a superheavy-lift booster requires capital investments to the tune of R4 billion. But the multilaunch profile requires the perfection of docking hardware, the transfer of the modules between craft, in-orbit assembly, the pumping of fuel, and crew transfers, all of which also involves big outlays.Let us try to extend the analysis to the base's functioning stage and subsequent build-up. It turns out that, in the context of a regular replacement of base personnel and the rather large requirements for material-technical supply, the outlays for the scientific-research and experimental design work associated with the creation of a superheavy-lift booster would be recovered after about five-seven years of base operation. We wouldn't want the reader to think that a problem as complex and varied as the creation of a lunar base is really a very simple one. Some additional in-depth

studies are needed, and we could devote another article to them. But we feel that the existing injection systems and the experience we've amassed in supporting the activity of man in space enable us to move at this point to consideration of the question of creating a lunar base.

Early Program for Development of Winged Orbital Spacecraft

927Q0112 Moscow KRYLYA RODINY in Russian No 11, Nov 91 p 25

[Article by Valentin Bobkov: "Space 'Sandal'"; first three paragraphs are source introduction]

[Text] **While the USSR and the United States were developing the first manned spacecraft in the world in the form of the Vostok and the Mercury vehicles, rocket and aviation specialists did not abandon the idea of descending from artificial Earth satellite orbit and landing on wings.**

The Dyna Soar space glider project was born in the United States, and the USSR was developing designs of winged satellite-vehicles in P. V. Tsybin's experimental design bureau OKB-256 and V. M. Myasishchev's OKB-23 of the State Committee for Aviation Equipment in the USSR Council of Ministers.

Our story is about of them—a Soviet space glider for reentry and landing.

In the context of an agreement between the chief designers of OKB-1 and OKB-256—S. P. Korolev and P. V. Tsybin—the preliminary design of such a vehicle was developed in OKB-256 and was confirmed by Pavel Vladimirovich Tsybin in May 1959.

According to the design, the space glider, with a cosmonaut aboard and a launch mass of 3.5 tons, was to be placed into a circular artificial Earth satellite orbit 300 km high by a Vostok-type launch vehicle. And after an orbital flight of 24-27 hours, it would make a reentry and return to the ground by gliding through the dense layers of the atmosphere. Initially, in the zone of intense thermal heating, the space glider would use the lift of its uniquely-shaped fuselage (hence the name "sandal," which was given it by S. P. Korolev-, and then, after slowing to a speed of 500-600 m/s, it would add, at an altitude of 20 km, the lift of its hinged wings, which spanned 7.5 m and were initially folded "behind its back." Control of the space glider during flight would be done with jet nozzles and air vanes. The nominal time from its reentry to landing was 1.5 hours. The space glider, with a mass of 2.6 tons, would land at a speed of 180-200 km/h on a specially equipped, unpaved airstrip on bicycle-type ski landing gear.

The fuselage—9 m long, 3 m wide, and 1.7 m high—was a structure that consisted of a steel skin welded to a heavy-duty frame. It was protected from thermal heating by a shield that consisted of organic-silicon thermal insulation 100 mm thick, combined with ultrafine fiber 70 mm thick, with air ducts for cooling the structure. The forward edge of the shield was to be cooled by liquid lithium. The same kind of cooling was to be provided for the leading edges of the horizontal elevon/control surfaces and the vertical rudders, which were made of steel and were blunt in front. According to calculations, the temperature on the forward part of the fuselage shield and the leading edges of the control surfaces could reach a maximum of 1200°C, as opposed to the upper part of the fuselage, where temperatures were not expected to exceed 400°C. The folded steel wings, which had an area of 8.7 sq m and a relative thickness of 5 percent and were in the "aerodynamic shadow" of the fuselage when the space glider was gliding with an angle of attack of 55-60°, would not be subjected to great heat-up when the vehicle was in the area of maximum thermal flux and was traveling at hypersonic speeds. Two pressurized compartments were to be located inside the fuselage: a cosmonaut cabin and an instrument compartment, both made of aluminum alloy and protected by additional thermal insulation. The cosmonaut cabin had an instrument panel and an ejection seat (the seat had three positions: a position for launch, a position for work, and a position for resting), as well as equipment for life-support systems. In addition, the cabin had two side viewports and a viewport for the astrotracker.

In the event of a launch failure at altitudes of under 10 km, the cosmonaut could eject from the cabin; at higher altitudes, there would be an emergency separation of the space glider, the wings would unfold, and the vehicle would descend to the ground.

The instrument compartment contained the equipment necessary for orbital flight and reentry. Some of it was mounted inside the fuselage. The total mass of the equipment was 600 kg, whereas the total mass of the glider was 1850 kg, including the thermal shielding. During the orbital injection and orbital flight legs, the space glider had a suspended propulsion system enclosed in a fairing and adjacent to the fuselage shield. The system included fuel tanks with oxidizer and propellant (nitric acid and kerosene), a fuel-feed system, and two liquid-fuel rocket engines: a retrorocket and a vernier engine, each with a thrust of 2350 kgf. Also mounted on the propulsion system were a sensor of the infrared vertical of the control-of-motion system and a radiator-emitter of the system for thermal regulation in orbit. The propulsion system had a mass of 350 kg and initially carried 430 kg of fuel. It separated from the space glider at an altitude of 90 km after providing a correcting impulse that changed the inclination of the descent trajectory. For attitude control in orbit and during reentry into the dense layers of the atmosphere, there were jet nozzles that each had a thrust of 3 kgf and burned hydrogen-peroxide decomposition products; 120 kg of hydrogen peroxide was carried. Subsequently, the air vanes would be brought into play. The unit load on the fuselage shield during reentry at hypersonic speeds would be 115 kgf/sq m, and the lift-drag ratio (at an angle of attack of 60°) was at least 0.6.

The space glider began gliding at subsonic speeds at an altitude of 10 km, with equivalent airspeed steady and lift-drag ratio at 4.5.

The landing would be made on skis, first on the aft gear and then on the forward, with a vertical rate of descent of no more than 2 m/s. The unit load on the bearing surface of the space glider during landing would not exceed 90 kgf/sq m.

S. P. Korolev was well-posted on all the work being done on the space glider in OKB-256. Spacecraft and booster specialists from OKB-1 were involved in that work. Also involved were large groups from the Central Aerohydrodynamic Institute and the All-Union Aviation Materials Institute. As we know, for the first spacecraft, the Vostok, Sergey Pavlovich [Korolev] chose a simple, reliable configuration that required the least expense of time and money for experimental development. Moreover, the campaign that got under way in those years against military aircraft, in favor of rockets, affected many experimental aviation design bureaus. In 1960, OKB-256 was shut down. Chief Designer P. V. Tsybin went to work as Korolev's deputy chief designer in OKB-1, where he made a considerable contribution to the development and construction of a modified version of the Vostok spacecraft, the new Soyuz and Soyuz T spacecraft, and unmanned interplanetary probes and the Molniya communications satellite. The materials detailing the space glider were transferred to A. I. Mikoyan's experimental design bureau, where work got under way then on the aerospace system Spiral (see KRYLYA RODINY Nos 11 and 12, 1990; No 1, 1991). The experience garnered in that project helped later in the development of the Soviet Buran orbiter.

Insufficient Electrical Power Limits Mir Space Station Utility

927Q0136 Moscow KURANTY in Russian
No 21, 1 Feb 92 p 6

[Article by Boris Olesyuk: "Is the Mir Station a Commodity?"; first paragraph is source introduction]

[Text] **Is it true that the Americans want to buy the Mir space station from us? The question can be put another way: Is such a deal possible in principle? And generally speaking, is the Mir station a commodity?**

I actually witnessed an argument the other day that was about this: Is the Mir space station the largest unique structure ever to be in orbit, and is it true that the Americans don't have anything like it and that they even tried to buy it?

The mass of the American orbital station Skylab, to which three missions were sent in 1973-74, was 77 tons. If you add the docked modified Apollo craft (18.5 tons) to that, then the total mass of the complex is more than 93 tons. The weight of the Mir orbital complex, with all the modules and the Soyuz and Progress spacecraft, is somewhat less, at 85 tons. The potential for Mir to surpass its late foreign colleague in the weight category, however, is not exhausted. Two docking ports on the forward section of the station are, as before, unoccupied, and they have been waiting three years for two 20-ton modules that have been sitting around for a fairly long time—an optical module and an ecology module. It's hard to believe that such things can happen in this day and age.

Nor can you leave out of the calculations the American reusable Shuttle, whose maximum weight with payload in orbit is just short of 120 tons.

Alas, our country, which has a variety of rocket-space hardware, has yet to be able to break into the world space market and become competitive with its products. The United States and France are holding their ground firmly there. Our Glavkosmos was not ready for such a turn of events, and not it can't get by without a market—based space economy. And it's in vain that the general designer of NPO Energiya Yuriy Semenov is complaining about the rigid position being taken in that matter by the United States, which doesn't want the presence of a dangerous competitor in the space market. But the term "dangerous competitor" is not, I think, entirely apropos here. Every businessman is fully aware of this indisputable truth: if you want to sell, you have to deliver high-quality goods at an acceptable price. The reason behind our failures is entirely explainable: inadequate technical level. And of course, anything can be sold: rockets, spacecraft, and even orbital stations.

But to sell the Mir complex!? That's doesn't have the ring of common sense. I don't think I'd be too far off base if I said that the beautiful phrase that's caressing our ears is more like an April Fools joke. When I read about it, I couldn't even imagine who could conceive of such an absurd thought. Either our semiofficial publication is being arch once again, or, as before, it considers us all fools. The question wasn't discussed in the U.S. Congress, and NASA didn't discuss it. Does anyone really think we would find a buyer for such a piece of space junk? Alas, it's more like a pipedream than a fact.

Let's take an honest, sobering look at some specific things. The space complex is beautiful on paper only. In real life, it's a very unsuccessful construction that has not shown its positive qualities in its operation. In orbit for twice the length of its useful life, unfinished at only half of its nominal capacity, poorly supplied with energy, the station has aged in six years both conceptually and physically. That's the hard reality. No one in his right mind could covet that "property."

Let's assume the improbable, that the Americans went ahead and became the owners of Mir. Then, for God sakes, I can't fathom how the NASA specialists could operate the complex with its low level of automation and its obsolete science equipment. Even as a joke, you couldn't presume that the American astronauts would become, like ours, repairmen and assemblers. And how

would the matter of supply of the station be resolved? In a word, there would be oodles of problems.

However, it's not just the ancient age of the station that would scare off buyers. From beneath all the other problems they would pull out the key problem—the power supply for the complex. In shop talk, the cosmonauts are always experiencing a deficit in electrical power. What's the cause of that?

The space solar electric power plant of Mir, as we know, works on the principle of direct conversion of the Sun's radiant energy into electrical energy. That process is performed with semiconductor photocells located on the power panels of the base unit, the Kvant-2 and Kristall modules, and the Soyuz and Progress spacecraft. The total useful area of the complex's solar arrays is 250 sq m, and the maximum output is 28 kW. But that, as they say, is in theory. In actuality, everything looks different. The fact is that the unforeseen piling up of the power panels has resulted in a loss of 40 percent of the nominal output because the panels shade one another's working area. We've tried to correct the situation by moving the solar arrays from the Kristall module to the Kvant module, for which cosmonauts Viktor Afanasyev and Musa Manarov performed preparatory work. To our profound chagrin, those hopes were popped like a soap bubble.

And there's another important thing. The solar cells are not guaranteed stable over a lengthy period of time, and the photocells are gradually aging and degrading, and their not-so-great efficiency (10-12 percent) is dropping considerably. In a word, the true output of the solar power plant of the complex is barely 10 Kw. You can't get a running start with that.

Just how did the intriguing story about the purchase of our Mir come to start trotting around the globe? From the looks of it, it has to do with the project involving the development of the orbital space station Freedom at a cost of $30 billion. Taking part in the design of the station is not only the United States, but also Canada, Japan, and the countries of the European Space Agency. American engineers show a great interest in the assembly and operation of our Mir station, and at some meeting, maybe, the conversation went on about it.

And something like this has been considered. A group of engineers from the public Space Research Center has suggested slowing the work on the creation of the expensive station and, in its place, moth-balling, repairing, and putting into orbit the backup Skylab orbital laboratory that is in the Air and Space Museum in Washington. A version using our superheavy-lift Energiya rocket has been considered to put it into orbit.

However, a new element in the arsenal of U.S. launch equipment in the not-too-distant future will be the Shuttle-C expendable transport system. The winged aircraft is replaced with an unmanned cargo vehicle. The cargo bay of that stage can carry up to 68 tons of payload. It is believed that the new rocket will find broad use for the delivery of up to 300 tons of orbital station Freedom elements to orbit. The first flight of the Shuttle-C is planned for 1994.

Our space program has experienced successes, blunders, and damage. In the final analysis, we have fallen hopelessly behind, especially in manned space. In my view, Mir has essentially exhausted itself and has done all or almost all it could do. It's useful life is over. I don't want to predict any further development of events, but right now Mir is going through hard times. To whom does the orbital station—our national property—belong? To no one. It's in abeyance. Traditionally, the station is occupied by NPO Energiya, but Energiya has just one thought: how to patch up the hole in its own emaciated budget. The Russian ministry doesn't have any time for the facility. A dramatic situation came about in December. Communications with the station, we know, go through shipboard and land-based tracking stations and a satellite relay link located in geostationary orbit. The Altair satellite departed this life, and the ships left the Atlantic. But the track of Mir is such that everyday on six of its orbits it is not over our territory, but is flying over land masses and oceans of other parts of the planet. And that's nine hours without communications with the cosmonauts. Mir should get a good, caring owner. Who would that be?

Semipalatinsk Scientists Working on Nuclear Rocket Motor

PM1904174192 Moscow KOMSOMOLSKAYA PRAVDA in Russian 15 Apr 92 p 1

[RIKA report: "Flights to Mars"]

[Text] Physicists of the scientific and technical complex set up on the basis of the Semipalatinsk nuclear test site are working on development of a nuclear rocket motor capable of sending a manned spacecraft to Mars. This work has become possible thanks to the conversion of the test site carried out by decree of the president of Kazakhstan. Scientists now have three nuclear test reactors at their disposal.

'BOR' Flight Test Craft for Spaceplane Program

927Q0155 Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 1, Jan 92 pp 42-43

[Article by V. Ageyev, under the rubric "Unknown Pages in the History of the Space Program: "The 'BOR,' in Flight"]

[Text] Between 1966 and 1976, the M. M. Gromov Flight-Research Institute did work involving the creation of the orbital craft of the Spiral aerospace system. Just what was that system?

The two-stage space system developed in the A. Mikoyan OKB [special design bureau] under the supervision of

Chief Designer G. Lozino-Lozinskiy consisted of a 52-ton booster aircraft and a 10-ton experimental manned orbital airplane (EPOS) that had a length of 8 m and a 7.4-m swept wing and launched from the "back" of the booster aircraft (at an altitude of about 30 km).

The subsonic EPOS prototype that was created in the mid-1970's (article No. 105.11) resembled today's Buran, but was smaller. Like any airplane, it had wings, a tail assembly, and controls: ailerons, a rudder, and a body flap. Only the landing gear looked unusual. It had four struts located in pairs along the fuselage, and on them were not wheels, but metal skis that enabled the craft to land almost anywhere. Test pilots I. Volk and V. Menitskiy flew it, as did Heroes of the Soviet Union A. Fedotov and A. Fastofets. Later, the flights of the version involved its release from the Tu-95K carrier-aircraft.

Of course, every new generation of aircraft contains a number of fundamentally new designs. But unlike in aviation, in which various modes can be gradually tested over many years in the process of perfecting a version,

the spaceplane craft had to give assurance that it would meet the reliability requirements in the very first flight. After all, during reentry and subsequent descent, such an aircraft would go through all the regions of gas dynamics—from the free molecular current to the classical boundary layer. Which is the reason for the creation of flying models (in 1:3 and 1:2 scales) that were called "BOR" and were used to solve those problems and to handle matters involving control of the EPOS at supersonic and subsonic flight speeds in the upper atmosphere, as well as to evaluate the temperature conditions on its surface.

The story of the creation of that model is interesting. Back in 1967, research plans called for the manufacture of a BOR flying model that would weigh as much as 800 kg and would be 3 meters long and would separate from a booster rocket (at an altitude of 100 km at 3.7 km/s) and would perform a glide in the atmosphere. But how were the developers going to solve the problem involving heat shielding for the structure of the model, whose nose section would heat up to 1500-1600°C? Prominent aerodynamics specialists were doubtful that it would be possible to balance an aircraft of such unusual profile—the "load-bearing body" was at angles of attack of up to 45°. But a solution had to be found as quickly as possible, since the fate of the entire Spiral project depended on it. In two years, the flight-research institute managed not only to complete the design, manufacture, and ground testing, but also, working with the rocket builders, to perform launches of the BOR in July 1969. Test results showed that the "load-bearing" body was marvelously balanced even at angles of attack exceeding 60°. And although the first model was made of wood and was equipped with the gear of a size/weight mockup, it was the model on which the scientific results, before its combustion loss at altitudes of 60-70 km.

After research was done in full flight conditions on the large-scale BOR-2 and BOR-3 models, the balance and the characteristics of longitudinal stability were refined (as compared with wind tunnel data). Experimental data were received on the transition from laminar boundary layer to turbulent layer, as were data on the effect of altitude and speed of flight on distribution of pressure on the surface of an aircraft with a complex geometrical shape. Algorithms for control of motion were tested, and broad studies were done on aerodynamic heating, heat exchange, and thermal protection for various surface elements.

An in-depth study of the data obtained demonstrated that the problems under examinations could not be solved in full flight conditions in the traditional manner on just one type of orbital-craft model. For that reason, the flight-research institute proposed conducting them on two flying models.

One model—the BOR-4—was a version of an aerodynamic vehicle with a "load-bearing body" on which actual fragments of the blunt upper and lower surfaces of the leading edges of the orbiter fuselage were reproduced (in size, shape, and construction). The model was intended for studying aerodynamic heating, heat exchange, and the thermal protection of the orbital craft in conditions close to those of flight in the atmospheric segment.

The other model—the BOR-5 (a 1:8 scale model of the orbiter)—flew in a trajectory that involved the necessary similarity criteria, and it was intended for studying aerodynamic characteristics and heat exchange. The first BOR-5 was sent into an artificial Earth satellite orbit, the second, into a suborbital trajectory.

On 4 June 1982, the BOR-4 aerospace plane, with a large lift-drag ratio, performed a flight of several thousand kilometers for the first time ever. In the process, the test craft entered a designated region of the Indian Ocean precisely. The precise entry was made possible by its control system, which was capable of handling navigation problems and effecting motion both in space and in the atmosphere, plus reliable thermal protection. Essentially, that flying model differed from the full-scale model only in its size, the absence of onboard targeting systems, and lower requirements for reliability and convenience of operation.

In the manufacture of the BOR-4, the brittle thermal-protection tiles were very worrisome. Even the slightest contact or tapping with a finger could leave dents in them, and because of that, they had to be replaced quite often. Here's what senior staff member at the institute I. Khanov recalls about that:

"Finally, everything was ready, and BOR-4 was placed on the booster rocket, which was already fueled. The launch was to be at night—it had to be, so that the model could land at dawn and there would be as much time as possible left for search and rescue. Orbital injection and separation from the launcher went fine. Communications went down, and everyone felt that that had happened too early. But the veteran testers assured us that it's always like that with high trajectories. We had to wait. And then came the report from the test director V. Vladychin that communications had resumed: the model was in a reentry trajectory, and all systems were fine. Now came the most crucial stage—the long flight in the atmosphere, with entry into the designated landing area. Again the communications were interrupted. Now the vehicle was in the plasma, and because of that, the situation was tense. Finally, the parachute system triggered. BOR-4 landed safely, or rather splashed down safely. But the coordinates differed from the nominal coordinates by almost 200 km! The controllers were upset. General G. Leksin, who was in communication with the control center, lightened the situation up by saying, 'Well then, give us the other landing coordinates, please. What are you trying to do—keep them to yourself?' But then a report came that said the article had been found by the search ships, and everyone breathed a sign of relief."

The choice of such a complex flight path for the article was for three reasons: to provide maximum safety in the performance of the assignment; to enable a splashdown, to preserve the integrity of the thermal-protection tiles; and to obtain the needed information on flight trajectory and operation of onboard systems. Once there were assurances of the complete reliability of the operation of the model's design and systems, the landing region was switched to the Black Sea.

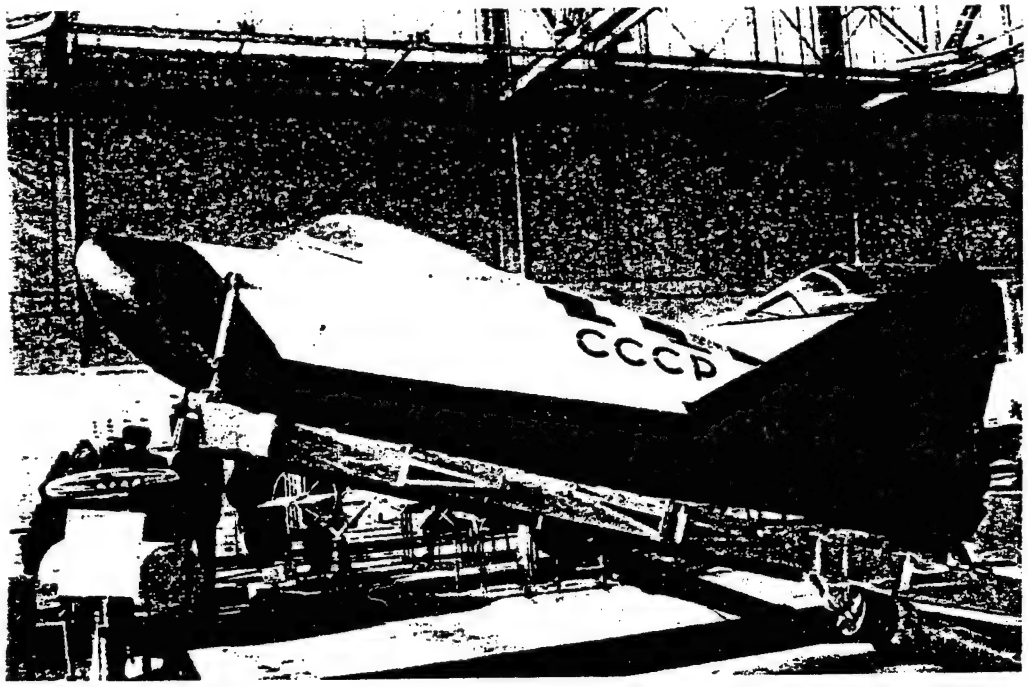
The flight involved a broad program of studies of thermal and aerodynamic characteristics that were difficult or impossible to model on the ground.

The study of aerodynamic heating and the testing of the orbiter's thermal protection were done at altitudes of 120 km down to 30 km and at flight speeds of 7500 m/s down to 1200 m/s on the BOR-4. The model was put into artificial Earth satellite orbit from the Kapustin Yar launch facility as maneuvering satellites of the Kosmos series (Nos. 1374, 1445, 1517, and 1614). The BOR-4 vehicles were our first aerospace planes capable of maneuvering in the atmosphere by means of use of the lift-drag ratio of the "load-bearing body" and the aerodynamic rudders.

The research that was conducted made a substantial contribution to the development of the design of the thermal shielding for the Buran orbiter and enabled refinement of the maximum temperature values for the various elements of its structure. The efficiency of a number of new thermal-protection materials and carbon-carbon structural units was assessed, as was the passability of radio waves through the plasma.

Flight tests involving the aerodynamic characteristics and the heat exchange were continued on the large-scale BOR-5 model. They were done in nonsteady-state flight mode at speeds of 5000 m/s down to 200 m/s and at altitudes of 120 km down to 10 km. Those tests revealed (with a high degree of reliability) the relationships between basic aerodynamic characteristics, on the one hand, and altitude and Mach number, on the other. A substantial nonlinearity was identified in the relationship between yawing moment and sideslip angle. All that indicated the need for certain changes in the aerodynamic configuration of the Buran orbiter, and those changes were made before the craft's first flight.

The results obtained indicate that the development of the orbital craft has led to the creation in our country of a highly effective scientific research complex that could be used with success to the benefit of the French Hermes project, the English HOTOL, and especially the NASP and Sanger projects, especially since the Europeans to date do not have access to the information assembled by NASA in the Shuttle flights.



Discussion of Capabilities, Commercial Role of 'Kuryer' Satellite System

927Q0128A Moscow VOZDUSHNYY TRANSPORT in Russian No 14, 1992 pp 8-9

["Business Club" roundtable organized and conducted by V. Petrova and V. Tseyukov: "Satellite at the Fair"; the first five paragraphs and the first section are an introduction, the last three paragraphs are an epilogue, followed by pertinent phone, TELEX and telephone numbers and mailing address]

[Text]

Business People, This Should Interest You

Today much is being said, and openly, concerning space: journalists, economists, philologists and simply ordinary people. And there are a great many, however strange it may seem, who are inclined to think that the money spent on space research goes into a bottomless pit. "Why do we need space today?" ask the impassioned supporters of the social revolution. Would it not be better to convert all space production, requiring many millions of rubles in subsidies, into shops for the production of not very expensive sausages and relatively inexpensive sets of furniture? And I sure would like to have it today..."

Yes, everyone says a lot and says it openly. But among these big talkers there once in a while slips in a sober restless thought: "But what to do with the people, the very people who were the first in the world to launch a satellite, the first to put a man into circumterrestrial space? And is it not too wasteful to curtail the space production which has brought us international recognition and authority?"

That is why the need has arisen among us to give an ear to those who today, despite the decay of intergovernmental bonds and interrelationships, nevertheless have found their place in this world—a world of a tumbledown, destroyed economy, destabilization of production and market anarchy. It would be interesting to learn how these people live today and how they view their calling and civil duty.

In order to answer the questions which have been raised, the newspaper editors, together with one of its founders, the Kosmo Scientific Research Center, also organized this roundtable discussion.

We think that the discussed subjects will certainly be of interest to business people.

In Place of a Foreword

As stated by N. Dmitriyev, general director of the Kosmo Scientific Research Center, a retired major general, in opening the roundtable discussion, by order of the Ministry of Defense of the Commonwealth Countries, our industry is developing one of the new space systems. Its purpose is traditional. But what, thought the specialists of the Elas Scientific Production Association and the Polet Production Association, if it was not limited to the traditional, but possibilities were sought for broadening the applicability of this system for carrying out scientific and economic assignments?

Representatives of the Ministry of Geology, Geos Interbranch Scientific- Technical Complex, Morsvyazsputnik Intergovernmental Association, Soyuzzhildoravtomatizatsiya Scientific Production Association, Applied Mechanics Institute, Glavkosmos and other interested organizations were invited to a roundtable discussion in the editorial offices.

The Electronic Mailman is Knocking on Your Door

[V. Karasev, director of the OPTEKS Scientific Production Center]

Time is hurrying us along. Today space-related industry and Elas scientists, jointly with the Polet Production Association Design Bureau from Omsk and a number of academic institutes, are in earnest engaged in work on the application of our technical concepts in the economy. In particular, data production, communication and data exchange are involved. Here, as they say, there is no end of work.

The second important assignment is ecological monitoring, that is, monitoring of forest fires, floods, mudflows, damage to gas and oil pipelines, and so forth. Even today timber industry and oil pumping enterprises, as well as different "green" organizations, are showing enormous interest in this research. Incidentally, we also earlier carried out work on observing the Earth's surface by means of space vehicles. But only now have we taken on a multisided solution of the problem. A regional principle has been adopted as the basis. We have already established communications with the Ulan-Ude, St. Peterburg, Baltic and Aral regions and are holding discussions with Mogilev region.

Since last year, in collaboration with the design bureaus of the Polet Production Association and the Geos Interbranch Scientific-Technical Complex, finalization work has begun on a low-orbit satellite system for data transmission using the 'Informator' spacecraft. The project is called 'Kuryer.' The Polet Association is finishing up on construction of a second vehicle, more perfect than the 'Informator.' Its launching is planned for early 1993. A surface terminal has already been developed and its standard production has begun. By late 1993 we are planning to place with users several tens of thousands of such terminals. So that beginning in 1993 we will be ready for experimental operation of the 'Kuryer' system in an "electronic mail" mode.

[V. Adzimamudov, head of a scientific research section at the OPTEKS Scientific Production Center]

In theory ecological monitoring can operate in an "electronic mail" mode. We are ready to supply the most complete information possible to interested users, to monitor the environment, to report on natural calamities

and extraordinary situations. Beginning in the second quarter of this year a receiving-transmitting station will be put into operation which, really, also will ensure the organization of "electronic mail." From space Moscow will be seen in the form of a circle with a diameter of about four centimeters. In the future the resolution may attain 75 meters. And this means that it will really be possible to detect and on an on-line basis report on the outbreak of forest fires and to ascertain the limits of forest species. And since our equipment makes use of microelectronics, it will be easy to work with it.

SS-20? This is Nothing So Terrible

[V. Kolotkov, deputy director of the OPTEKS Scientific Production Center, Elas Scientific Production Association]

As Karasev has already noted, the 'Kuryer' satellite system is intended for solving a wide range of problems: monitoring of the precursors of extraordinary situations and natural calamities (earthquakes, floods, tsunamis, forest fires, etc.), exchange of information with a wide range of users (banks, stock exchanges, industrial, scientific and educational centers, trade, marketing, public health institutions, etc.), monitoring of the efficient use of natural resources, ecological monitoring and tracking of moving objects.

The leading enterprises of our Commonwealth are participating in development of the system: Elas Scientific Production Association, Polet Production Association, Moscow Institute of Heat Engineering, Instrument Making Scientific Research Institute, Radio Instrument Making Scientific Research Institute, Applied Mechanics Scientific Production Association (Krasnoyarsk), Moscow Physical Technical Institute, Physical Technical Faculty of Tomsk State University, Division of the World Laboratory, and others. You will probably be interested in learning what fundamental principles are applied in organizing such a large-scale project? First, the use of all-possible now existing space-, aircraft- and surface-based equipment and dual-purpose military systems, that is, those which can be used in the interests of both defense and the economy.

The system includes space vehicles of the 'Kuryer,' 'Okean,' 'Meteor' and 'Resurs' types and the relay satellites 'Geyzer' and 'Gorizont.' A rocket-space system with a 'Kosmos' rocket and a space vehicle of the COSPAS, 'informator' type, as well as a mobile launching system known in press reports as the SS-20 and SS-25, also are used.

The system operates as follows: satellites or aircraft "photograph" the Earth's surface and then the collected information is transmitted through radio communication channels to reception points where it is processed and sent on to a user.

A Satellite Conserves Oil

[T. Kondranin, professor, chief designer, OPTEKS Scientific Production Center]

It must be honestly admitted that existing remote sounding systems, unfortunately, do not provide adequate quantitative information. Today the problem of obtaining space photographs, their thematic processing for the purpose of obtaining information on the state of the atmosphere, cloud cover and underlying surface and on the movement of cyclones, has been solved.

And so we are not in a position with our available technology to obtain quantitative information on the concentration of any atmospheric gases or on the pollution level of the coasts of oceans and seas. I would like to draw attention to the fact that 20 percent of this information (in addition to space photographs) is obtained by means of remote sounding apparatus and the remainder is obtained by other means.

You yourselves understand what importance is given to aerial and surface data collection systems. The proposed aerial universal system is of a high scientific and technical potential. It can detect sea surface anomalies and track moving objects. By means of this system it is possible to determine surface temperature with a high accuracy, soil moisture content and the ground water table and the extent of snow fields.

There also are a great number of economic problems which can be solved only when very precise information is available. A case in point is determination of the locations of leaking of oil and gas pipelines. For example, in Tyumen Oblast alone there are 6000 km of main pipelines and these are joined by 24 000 km of field pipelines. The natural conditions in Tyumen Oblast are such that a high percentage of the oil and gas pipelines is laid out on the ground surface. According to statistics, each three kilometers of such lines have microleaks. Although a microleak does not inflict damage, it may result in a change in the infrastructure differing from the background.

It is becoming clear that with such a scale of the areas involved, taking into account the inaccessibility of most of the regions, the monitoring problem can be solved only by aerial or space observation. But the aerial system is very expensive: the cost of one flight hour is 13 000 rubles. On the other hand, the return from our system is very high. For example, in the case of forest fires the yield-to-cost ratio is 10:1. Ten rubles of profit for each ruble spent.

Oh, and We Already Have Littered Space

[N. Prikhudaylov, key specialist at the Ministry of Defense Scientific Research Institute]

We all are speaking of problems which, so to speak, are of terrestrial origin. But ecological problems, indeed, also are acute in space. The contamination of space by objects of artificial origin is continuing. There in circumterrestrial orbit there are up to 7000 visible objects

measuring from 30 cm or more. Among these 44 percent are objects forming as a result of destruction, 20 percent are those which have outlived their useful life, 16 percent are booster stages and 14 percent are the results of space activity: wastes from stations, etc. Another 6 percent is accounted for by active space vehicles.

The maximum density of artificial objects falls at an altitude from 800 to 1500 km, inclination 65, 75, 90 degrees. That is, where we intend to fly.

I want to mention that the visible objects constitute 0.2 percent of all those present in space. But for a size 0.1 cm the total is 3.5-4 million. We cannot range them. How dangerous are they? Here is a clear example. A collision with an aluminum sphere with a diameter of one centimeter moving at a velocity of 10 km/s is equivalent to a collision with a safe weighing 200 kg moving at a velocity of 100 km/hour.

If no measures are taken (and our evaluation is consistent with the conclusions drawn by American scientists), the contamination may attain such a density with which an uncontrollable chain reaction might occur due to the formation of secondary fragments as a result of collision. And the probability of collision itself increases to 50 percent.

Our proposal? Use a system for monitoring space contamination. This is entirely within our capability.

The Polet Production Association Bursts Into Flight

[V. Ilin, key specialist at the Polet Production Association Design Bureau]

One of the important tasks which our system can solve is the monitoring of moving objects: sea and river ships, railroad trains, auto traffic, etc. And space vehicles of the 'Kuryer' system are assisted in this by their very good navigational support. The accuracy in determining the coordinates of a moving object is from several hundred meters to 1 ½ kilometers. This part of the 'Kuryer' project was developed by us to a lesser degree, but the Polet Production Association Design Bureau is carrying out such work in collaboration with the Instrument Making Scientific Research Institute and the Morsvyazsputnik Intergovernmental Association within the framework of the 'Kurs' system. I assume that the combining of this work will make it possible both to lessen the total cost and accelerate development and construction and to broaden the possibilities for application by users.

[N. Ivanov, section head at the Polet Production Association Design Bureau]

I want to continue Ilin's thought. Individual space systems, as is well known, are complex by nature. They constitute the greater part of the makeup of multipurpose space systems. Rational approaches must be used in their development and construction, related, in particular, to the freeing of the resources of the defense industry, the use of those available facilities already at their disposition.

We feel that a very definite step-by-step approach in system development is very important. It is proposed that purposeful modules be developed for the timely conducting of flight-design tests and obtaining adequate experimental data for developing standard systems. Reference is to modules of purposeful apparatus used on spacecraft. It is necessary to develop experimental systems and finalize the entire information channel for collecting data and sending it on to the user.

We have definite experience in the use of space systems for specific users. We propose that the initial finalization work be accomplished on the basis of the COSPAS space vehicles. These are reliable spacecraft which have proven themselves well. We have great experience in their use. And thereafter, having a modular multipurpose spacecraft design we will be able to combine successfully the solution of the most diverse problems. But the most important thing is to have, as we say, a standardized service module, or, as it also can be said, a space platform. Modules for different purposes can be docked to it.

Ecology: A Space Profession

[M. Mazur, head of scientific research section at OPTEKS Scientific Production Center]

The ecological centers of the republic and regional analytic centers are solving local problems. It goes without saying that there is some difference between them. This applies to the makeup of the apparatus used.

The regional ecological system which we proposed consists of a network of user telemetric stations and a data collection platform. A mobile ecological laboratory consisting of several vehicles and an aerial ecological laboratory is assigned to a number of regional centers. The republic and regional ecological centers consist of autonomous points for the reception of space information, analytic laboratories, computer centers and mobile ecological laboratories, to which a training center is assigned. The mobile ecological laboratory consists of a communications truck, a laboratory truck, an auto repair workshop truck (in which instruments and equipment also are repaired) and a power station. These laboratories are organized using "Ural" trucks outfitted with definite equipment.

The Rain of Space Information Has a Life-Giving Force

[N. Dmitriyev, general director of the Kosmo Scientific Research Center]

Summarizing the results of today's discussion, I say that those present here, as well as the readers of VOZDUSHNYY TRANSPORT, will discover more than a little which is useful for themselves. It must be confessed

that earlier we preferred to speak of many space professions in hushed tones. Today we simply must tell businessmen and the directors of production enterprises how useful space technology can become for them. And the point is not that we want to salvage the technology itself, although this is the most important thing for today. It is simply impossible to squander in response to the slogans of the moment that which was the product of the work of decades by the best minds in the country. Society, split by its narrow political interests, must listen to the voice of specialists. The situation today is quite paradoxical: information is literally pouring from space, but in essence no one has access to it. It seems to us that it is sufficient to instruct people, to help them to work with our equipment and to feed the information directly to those who have need for it.

[V. Karasev]

I want to support Dmitriyev. We are planning to carry out a cycle of experiments and to deploy local regional systems before 1993. We intend to work first of all with those regions where there are trained specialists. For example, let's take St. Peterburg. The highest level of training of specialists is available there and we propose to contact them. There are those we can rely on. There are those to whom we can give our equipment for active use. That's of more than a little importance. The surmised users—be they individual scientists or entire scientific teams—are being outfitted with personal computers, are purchasing a terminal station and are signing on as subscribers. Information from space will be received on a routine basis, without any delay, and will immediately be put to use.

It is now already possible to answer the question unambiguously as to whether there is a user for this system. I refer to the 'Kuryer' system. There is. And our foreign colleagues also have been captivated by this project.

Our position is to implement a policy of open, not closed doors. We are creating the core—the information part, all of whose components can link up with any structure, any system.

Naturally, we require mind power, people understanding the physics of the process. Yes, all of us are from different cities and if we come to think along the same lines we will be able to cope with our task at the Commonwealth level.

Judging from the exchange of opinions in the lobbies, both the developers and the users are finding a common language. They expressed their opinion directly: "The system will be a go."

It was pleasant to see how the respected space production specialists gladly discarded the habit of secrecy so engrained in this field until recently. Former military men and scientists in the presence of possible clients conducted themselves in a completely unfettered way. A comparison with a fair even came to mind. In the last analysis, why not? Business is business.

Everyone is ready to go ahead—to carry out work on implementation of the proposed decisions in his own sphere. The thing which pleased virtually all the specialists most was that there are already in-place ideas and specific "working systems" which can be put into practical use. Indeed, the advantage of the system is that not everything has to begin from point zero. And this means that there is a real possibility, even without this, to make most efficient use of our scanty national resources for the speediest possible emergence of the Commonwealth countries from their deep crisis.

It is requested that all who are interested in the project communicate by the business telephones (095) 928-51-01, (095) 925-81-55. FAX (095) 292-65-11 OPTEX 1588. Teletype 417414 OBVOD. TELEX 411700 OPTEX 1588. Mailing address: 103012, Moskva, Staropanskiy per., 1/5.

'Gorizont' Communications Satellite Launched

LD0204180792 Moscow ITAR-TASS in English 1752 GMT 2 Apr 92

[Text] Moscow April 2 TASS—The Proton booster rocket that blasted off from the Baykonur Cosmodrome today has placed a communications satellite, Gorizont, in geostationary orbit above the Earth.

Under the Russian Communications Ministry's programme for the further development of satellite communications, Gorizont is designed to transmit Russian radio and television programmes to Siberia and tackle other communications issues in eastern Russia.

The equipment installed in the satellite operates normally.

'Resurs F-2' Satellite Launched From Plesetsk

LD2904143192 Moscow ITAR-TASS World Service in Russian 1406 GMT 29 Apr 92

["Official—TASS headline]

[Text] [no dateline as received]—Another artificial Earth satellite, Resurs-F, was launched from the Plesetsk Cosmodrome by a "Soyuz" launch vehicle.

The satellite carries apparatus for taking multi-zonal and spectro-zonal photographs aimed at continuing research into the Earth's natural resources in the interests of various branches of the national economy, and the resolution of tasks of ecology and of international cooperation.

The satellite has been placed in orbit with the following parameters:

—Initial period of revolution—88.8 minutes;

—apogee—275 km;

—perigee—196 km;

—orbital inclination—82.3 degrees.

The apparatus on board the satellite is working normally.

On completion of the flight the exposed film will be handed to the "Priroda" [Nature] state scientific research and production center of the Russian Ministry of Ecology and Natural Resources' Committee for Geodesy and Cartography for processing and subsequent distribution among its consumers of the information gained.

Possibility of Satellite Measurement of Radiation Negentropy Influx to Earth for Ecological Research

927Q0070A Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 91 (manuscript received 6 Sep 90) pp 3- 15

[Article by M. N. Izakov, Space Research Institute, USSR Academy of Sciences, Moscow; UDC 551.583:341.12]

[Abstract] Some details of a method for studying the radiation negentropy influx (RNI) proposed in an earlier study by the author (KOSMICH. ISSLED., Vol 28, No 4, pp 617-626, 1989) are made more precise and estimates are made of the expenditure of negentropy on the planet Earth, including in the biosphere. Since RNI is a measure of all processes transpiring on the Earth, including biospheric, its variations can serve as an objective index of global changes in natural conditions on the planet. A study of the interaction between radiation and matter in an entropic representation makes it possible to find the dissipative function (rate of energy scattering in all dissipative processes and in each of them individually). Since entropy production always is nonnegative, it can be used as a Lyapunov function for investigating system stability. This can help in predicting probable changes in natural conditions in the future. If in addition to satellite measurements of radiation fluxes use is made of their vertical profiles, it is possible to compute the parameters of macroturbulent transfer from the equator to the pole, which it is difficult to determine and compute by other methods. If satellite measurements of radiation fluxes are supplemented by surface spectral measurements within the limits of an individual ecosystem it is possible to make computations of the productivity of the latter more precise. Figures 3; references 42: 27 Russian, 15 Western.

Simulation of Spectral Brightnesses of Natural Features at Upper Boundary of Atmosphere

927Q0070B Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 91 (manuscript received 7 Aug 90) pp 16-20

[Article by S. A. Ivanov and R. I. Kazak, Military Engineering Institute imeni A. F. Mozhayskiy, Leningrad; UDC 502.3.330.115]

[Abstract] A method was developed for writing a standard description of the spectral properties of natural features in spectral brightness space at the upper boundary of the atmosphere. The method is based on a mathematical model of radiation transfer through the atmosphere with application of Monte Carlo procedures and involves two principal stages, which are described in detail. The variability of the spectral brightness coefficients, as well as variations in atmospheric spectral transparency and the brightness of atmospheric haze, are taken into account by using information on the statistical characteristics of model parameters. The method was applied by preparation of programs in PL-1 algorithmic language using a YeS computer with two controlling programs and a package of supporting subprograms. The first of these is for constructing the vector of parameters for the reduced model (the procedures for whose preparation are outlined) and the second is for generation of the spectral brightnesses at the upper boundary of the atmosphere and evaluating the required parameters of the distribution law. The total time required for scaling the characteristics of features of one class to spectral brightness space for 60 wavelength values is roughly 10 minutes. The proposed method makes it possible to write standard descriptions of the spectral properties of features for an unrestricted number of wavelengths. Since it is possible to make allowance for the index of natural variability of the brightness properties of sounded features and also variations in atmospheric spectral transparency and the brightness of atmospheric haze, the method is considerably superior to existing approaches for solving such problems. References; 15 Russian.

Spectral-Angular Method for Determining Optical Characteristics of Atmosphere and Surface Applied on 'Salyut-7' Station Using MKS-M Data

927Q0070C Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 91 (manuscript received 18 Oct 90) pp 27- 35

[Article by V. V. Badayev, A. I. Lyapustin, I. M. Mansurov and T. Z. Muldashev, Space Research Institute, USSR Academy of Sciences, Moscow; Mathematics and Mechanics Institute, Kazakh Academy of Sciences, Alma-Ata; UDC 528.813]

[Abstract] Angular and nadir brightness measurements in the range 450-780 nm and in the absorption band 760 nm made using the MKS-M spectrometer on the Salyut 7 orbital station made it possible to determine optical parameters of the atmosphere and surface and to estimate the concentration of aerosol of anthropogenic origin in the neighborhood of an industrial smoke plume at Zaporozhye on 16 August 1985. The spectrometer axis was oriented to the nadir. The instrument was first calibrated using the sun and stability of its operation was checked by internal calibration signals. In all 19 measuring channels the MKS-M data were synchronous with a relative measurement accuracy to about 1 percent. During the experiment the station, by rotation, was

oriented with the instrument optical sight on the mentioned smoke formation. Measurements were made in four parts of the absorption band 760 nm with a spectral resolution 1.5 nm and in nine spectral intervals with a width 10 nm in the spectral range 450-788 nm. The derivation of the formulas for processing these data and their integration is given. The method will be useful in monitoring industrial effluent into the atmosphere, as well as volcanic eruptions and dust storms on a global scale. Figures 4; references 24: 17 Russian, 7 Western.

Linear Scanning From Artificial Earth Satellites and Determination of Ocean Surface Temperature

927Q0070D Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 91 (manuscript received 3 Sep 90 pp 36- 43

[Article by I. L. Dergileva and A. M. Ignatov, Marine Hydrophysics Institute, Ukrainian Academy of Sciences, Sevastopol; UDC 551.46]

[Abstract] A method is proposed for retrieving IR radiation angular structure in a horizontally homogeneous cloudless ocean-atmosphere system (OAS) using AVHRR/2 data from NOAA satellites. The proposed method, based on a histogram analysis of satellite data, is compared with others. The method was tested using NOAA-10 and NOAA-11 data. Angular structures over the waters of the Tropical Atlantic during summer and winter were determined in two AVHRR-2 channels. The accuracy of the histograms method in general is inferior to the earlier proposed averaging method, a condition for whose applicability is the writing of reliable cloud cover filtering algorithms. Possible directions in interpretation of the retrieved angular structures were demonstrated in the example of testing of a number of methods for determining ocean surface temperature (OST) used in routine practice and proposed in the literature. It was noted that the coefficients of linear evaluation of OST on the basis of one or two spectral measurements of a linearly scanning IR radiometer are dependent on the sighting angle. This fact, as well as the noncoincidence of OST estimated by the method of extrapolation to a zero air mass on the basis of measurements in different AVHRR/2 channels, constitute interesting physical phenomena requiring further study. The proposed method appears to be highly promising and requires further development in the direction of both an increase in the accuracy of the retrievable angular structures and an improvement in understanding of the processes of transfer of IR radiation in the OAS. Figures 4; references 15: 7 Russian, 8 Western.

Fractality of Spatial Structures of Geosystems

927Q0070E Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 91 (manuscript received 17 Dec 90) pp 59-67

[Article by L. N. Vasilyev and A. S. Tyuflin, Geography Institute, USSR Academy of Sciences, Moscow; UDC 911.2:(528.77-129.78)]

[Abstract] It is shown on the basis of an analysis of space photographs at different scales that the spatial structure of geosystems has fractal properties. Two types of structures were investigated: distribution of fields in agricultural geosystems and erosional networks. For each type of structures—vector fields and branching processes—methods are proposed for determining the fractal dimensions from space photographs. The research was carried out in territories with different types of land use. The properties of self-similarity of structures of the erosional and river network are manifested in a limited range of scales of branching elements. All statements made concerning the dependence of the computed self-similarity interval on the magnitude of a spatial resolution element made for land use structures also are correct for the erosional network. The difference is that the structure of an agricultural geosystem, being anthropogenic, is limited by the minimum size of an agricultural field, whereas branching structures, by nature, have no such definite limitation. For the inclusion of microstructures it is necessary to use large-scale photographs with decimeter resolution. The determined indices, found from multiband space images, can be used as generalized coordinates of a geosystem structure, especially in geoinformation and expert evaluation systems in which the compression of spatially distributed data is especially necessary. The fractal dimensions of the structures can be used in simulating optimization problems in land use and in theoretical geomorphological research. The final interpretation of fractal dimensions is always made using traditional quantitative and qualitative characteristics. Figures 6; references 9: 6 Russian, 3 Western.

Study of Conditions for Identification of Hail Precipitation on Side-Looking Radar Images

927Q0070F Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 91 (manuscript received 15 Oct 90) pp 74-82

[Article by M. V. Bukharov, USSR Hydrometeorological Scientific Research Center, Moscow; UDC 528.88.044.1]

[Abstract] A model of the scattering of a sounding pulse in hail-bearing clouds was constructed and used in studying their possible tonal and geometric indicators on images from side-looking radars (SLR) carried aboard oceanographic satellites. The geometry of scattering and the registry of the SLR signal in the presence of hail is illustrated in a diagram which serves as a point of departure for the discussion and derivation of formulas. Within the framework of the model expressions are derived for computing the intensity of precipitation and the altitudinal boundaries of the most scattering layer. Photographic tone contrast and the altitudes of the upper and lower boundaries of the region of maximum scattering and attenuation of the SLR signal were found to be the most significant identification criteria. An example of the identification of hail precipitation on a SLR image is discussed. In every case identification

correctness was checked by use of independent quasisynchronous data on the type and radar reflectivity of precipitation obtained using the new AKSOPRI surface automated system for the collection, processing and display of radar meteorological data. There was a complete consistency of the results obtained using the two systems with respect to both the presence of hail in clouds and the actual falling of hail. Figures 2; references: 9 Russian.

Space Radar Observations of Ice Shore Dynamics and Iceberg Drift in Antarctica

927Q0070G Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 91 (manuscript received 13 Jul 90) pp 87-96

[Article by V. A. Krobotyntsev, O. Ye. Milekhin, V. I. Popov and Yu. G. Spiridonov, Planeta Scientific Production Association, Moscow; UDC 528.873.044.1]

[Abstract] Radar observations from the Cosmos 1500, Cosmos 1766 and Okean oceanographic satellites were made for investigating the dynamics of the ice shores of Antarctica. Fragments of digital radar maps constructed as a result of computerized processing and individual radar images were analyzed. In 1986 a series of radar images was obtained showing the calving of three gigantic icebergs from the Filchner Ice Shelf and the onset of their drift in the Weddell Sea. In 1988-1989 a series of radar observations was made of the drift of a gigantic iceberg in the Ross Sea, whose calving occurred in 1987. The dimensions of the icebergs were determined from the radar imagery. The length of the Ross iceberg was about 150 km, its width was about 40 km and its height above the water was about 30 m, below the water about 170 km and the iceberg volume was 1200 km^2. The surface areas of the icebergs calving from the Filchner Ice Shelf were: western about 5220, central about 5260 and eastern about 6800 km^2; the total volume for the three was 3600-5400 km^3. The calvings of the gigantic icebergs in 1986-1987, which in their mass exceed the mean annual runoff of icebergs in Antarctica by several times, indicate an increasing dynamic activity of the Antarctic glacier cover and possible climatic changes. Radar observations from oceanographic satellites in the first half of 1988-early 1989 were used in constructing the drift trajectory of the Ross iceberg during this period and some characteristics of its drift were determined. The mean rate of iceberg drift in open water was 5.5 km/day, with partial freezing of the iceberg into the ice it was about 15.9 km/day and with total freezing in the ice it was about 9 km/day. During drift the Ross iceberg rotated counterclockwise at a mean rate 1-1.1 degree/day. Radar observations of the icebergs calving from Filchner Ice Shelf in Weddell Sea were used in estimating their drift rate during 1986-1989; 0.38-1.2 km/day. Figures 5; references 16: 12 Russian, 4 Western.

Determining Ocean Surface Temperature From Nadir Microwave Radiometer Measurements

927Q0070H Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 91 (manuscript received 4 Jul 90) pp 97-103

[Article by G. A. Bolotnikova, S. I. Grechko, V. G. Irisov, A. V. Kuzmin, Yu. G. Trokhimovskiy and V. S. Etkin, Space Research Institute, USSR Academy of Sciences, Moscow; UDC 528.873.041.1,3]

[Abstract] The results of joint measurements of the radiothermal emission of the sea surface in the 8-cm range, IR measurements and polarization measurements at wavelengths 0.8, 1.5 and 2 cm, carried out from an aircraft with observations to the nadir, are presented. In situ experiments made it possible to determine the dependence of radiobrightness temperature on the speed and direction of the near-surface (H = 20 m) wind under a wide range of conditions (2-20 m/s). OST (ocean surface temperature) determination with an accuracy to 0.5 K using measurements at long centimeter waves even under cloudless conditions requires solution of a three-parameter problem whose parameters are OST, wind speed modulus and wind direction. Polarization measurements at short centimeter waves are necessary for determining the latter two parameters. The best correction accuracy is attained with moderate wind speeds. A comparison of estimates of OST based on microwave measurements with IR data indicates that allowance for the parameters of the wind velocity vector, determined using polarization measurements to the nadir, makes it possible to reduce the dispersion of the regression dependence of the two estimates by a factor of 3. The excess of contrasts of OST retrieved from microwave measurements over the contrasts in the IR range is attributable to the presence and variability of a cold surface film and an increase in the amplitudes of gravity-capillary waves with a decrease in the stability of stratification in the near-water layer of the atmosphere. The results therefore indicate that OST determination from multichannel microwave measurements with an accuracy to 0.5 K is a multiparameter problem. New experiments possibly will confirm the need to take into account not only the speed and direction of the near-surface wind, but also parameters characterizing boundary layer stability. Figures 4; references 14: 9 Russian, 5 Western.

Remote Sensing of Agricultural Resources From Space

927Q0070I Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 91 (manuscript received 4 Feb 91 pp 122-126

[Article by A. A. Feoktistov, V. P. Bocharov and A. F. Molchanova, AIUS-Agroresursy All-Union Scientific Research Center, Moscow; UDC 528.8:63]

[Abstract] The AUS-Agroresursy All-Union Scientific Research Center is engaged in development work on automating the processing of remote sensing data on

agricultural resources from space. This article examines use of MSU-E high-spatial resolution data for the inventorying of agricultural crops in a multitime processing mode and analyzes the effectiveness of use of intermediate-resolution MSU-SK data for evaluating the state of natural pastures. A classification analysis of MSU-E data was carried out for Kherson Oblast using surveys on three dates with multitime data files containing six spectral planes (two channels for each of the three dates). Data in the most informative channel for all three dates were used in constructing a digital surface map containing 27 thematic classes. Then three classification processing cycles were carried out using data for one date, two dates and three dates. Those thematic classes were combined whose separation was unsatisfactory, reducing the number of classes to 15-20. The accuracies for the three variants were 60, 89 and 90 percent respectively, the 1 percent difference indicating that the choice of survey dates was not optimal but that the use of surveys on two dates was very worthwhile. Classification work for pasture lands in the Turkmen SSR with the MSU-SK yielded highly informative data. In both classification surveys there was a very good level of agreement between the results of space and aerial scanner information. References 6: 5 Russian, 1 Western.

Priorities of Global Ecology and Objectives of the Remote Sensing of the Environment and the Biosphere

927Q0098A Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 5, Sep-Oct 91 pp 3-9

[Article by K. Ya. Kondratyev, Institute of Limnology, USSR Academy of Sciences, Leningrad; UDC 502.5:528.8:629.78]

[Abstract] The Earth's thermal balance hinges on two phenomena—variations in solar energy flux, and anthropogenically based redistributions of components of the surface and atmospheric thermal balance, namely, intensification of the greenhouse effect as a result of the growing atmospheric content of greenhouse gases. The acuteness of the problems associated with those two phenomena calls for a global observation system that centers on satellites and can track the processes that are taking place in the biosphere and the environment. Such a system must be set up in the context of international cooperation, under the aegis of the UN. The writer of this paper compares "global change" programs developed by the United States and France. He notes that work done in the framework of the USGCRP, under the guidance of the CEES, can be regarded as a component of the WCRP and the IGBP and has the following chief objectives: the creation of an integrated, comprehensive, long-term program for documenting the dynamics of the planetary system on a global scale; implementing problem-oriented research to deepen our understanding of the physical, geological, chemical, biological, and social processes that affect terrestrial systems; and developing integrated conceptual and predictive models of the terrestrial system. Among the specific aims of the USGCRP are the invigoration of research that seeks the causes of climatic change and the intensification of integrated studies of greenhouse gases. Based on IPCC recommendations, four key areas of interdisciplinary research have been outlined: numerical modelling and prediction of climate; global water and energy cycles; global carbon cycle; and ecosystems and population dynamics. A program set up by the French CNRS is similar in its interdisciplinary approach and covers five key area: law and economics; environmental problems in a historical context; analysis of key natural systems and their evolution; understanding of the principal mechanisms and manifestations of anthropogenic effects on the environment; key aspects of global change. References 12: 6 Russian, 6 Western.

Study of the SVIT Complex for Analysis of IR Images of the Ocean Received From Meteor-2 Series Satellites

927Q0098B Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 5, Sep-Oct 91 pp 22-24

[Article by V. S. Suyetin, D. L. Grebenev, Marine Geophysical Institute, UkSSR Academy of Sciences, Sevastopol]

[Abstract] Prompted by the fact that a lack of experience in using modern digital video equipment to analyze space-derived IR radiometer data has kept much of data from the Meteor-2 series Chayka radiometer (BCh-100) from being analyzed properly, the researchers here used the SVIT video complex to examine the oceanological data capabilities of the Chayka by processing IR images of the ocean. The Chayka has a resolution of 8 km, with a distance between scan lines of around 20 km, and it transmits data to three ground-based receiving stations. As a target for the study, they selected a region of the western Atlantic that is well studied and manifests considerable, varied contrasts in ocean surface temperature (OST) field, i.e., the waters off the Florida Peninsula in the Gulf of Mexico and the Atlantic and the waters that make up the Gulf Stream along the East Coast of the United States. Three images produced by the radiometer indicate that the land temperatures on the Florida Peninsula are lower than the OST. The contrasts that show up in the temperature field of the water surface on those images are entirely typical for that region and are due to temperature fronts between colder shelf waters and the warm waters in the center of the Gulf of Mexico and in the various local currents The temperature differentials are demonstrated to reach several degrees. Three other images depict the region of the Gulf Stream to the northeast of Cape Hatteras and to the south of the Nova Scotia peninsula. Two of them demonstrate that the land temperatures are lower than that of the coastal waters, making the coastline rather easily distinguished. OST field is defined primarily by the characteristic seaward deflection of the Gulf Stream's main waters off Cape Hatteras and by the formation of a cold wall on its western boundary. Secondary fronts, meanders, and eddies are also distinguishable. OST field

contrast distributions typical for that region can also be seen. On certain of the images, the Gulf Stream off Cape Hatteras is easily distinguished as a narrow, warm ribbon. The boundary between the cold shelf waters and the warm water of the Gulf Stream can be seen clearly. Figures 1, references 8: 5 Russian, 3 Western.

Technique for Optimizing Parameters of Same-Orbit Satellite Systems for Intermittent Survey of the Earth

927Q0098C Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 5, Sep-Oct 91 pp 39-46

[Article by Yu. N. Razumnyy; UDC 629.783:778.39]

[Abstract] One of the most important factors affecting the economics of the use of satellites systems is the choice of ballistic configuration. One or more of three problems involving the optimization of system parameters are usually considered when that choice is being made: optimization in terms of minimum number of satellites in the system, optimization in terms of maximum interval between observations, and optimization in terms of minimum survey swath. The researcher here proposes a technique for designing intermittent-survey satellite system that optimizes for all three considerations. Optimum altitude is especially important to the technique in that it is an extremely sensitive parameter for intermittent survey: changing the altitude by several dozen kilometers can change the period of the survey by a factor of 1.5 and can necessitate changes in width of the survey swath and number of satellites. Figures 2, references 3 (Russian).

Determination of Chlorophyll Concentration of Phytoplankton in the Ocean From Measurements Made From the Mir Station in the Caribe-88 Experiment

927Q0098D Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 5, Sep-Oct 91 pp 47-55

[Article by V. V. Badayev, L. N. Vasilyev, V. N. Pelevin, V. L. Solomakha, and G. Tsimmermann, Institute of Space Research, USSR Academy of Sciences, Moscow; Institute of Geography, USSR Academy of Sciences, Moscow; Institute of Oceanography, USSR Academy of Sciences, Moscow

[Abstract] The space-based determination of chlorophyll concentration involves consideration of the effects of the atmosphere and the ocean on the spectrum of outgoing radiation. The effects of the former are determined by creating an algorithm for "atmospheric correction." Those of the latter are determined by extracting data from the spectrum of the radiation emerging from the seawater on chlorophyll concentration, as well as on other impurities that affect the light field at the sea surface as a result of their own light-absorbing and light-scattering properties. Researchers in the West handle the atmospheric correction by using the H. Gordon algorithm. In the work reported here, however, the researchers use a different approach. The atmospheric correction of the orbital data is performed with a technique that involves measurements in the 760 nm band and is based on the use of those measurements, as well as multispectral data on the outgoing radiation that are provided by the MKS-M tracer spectrometer on the Mir station. Determination of the concentration of impurities from the luminance spectrum obtained for the radiation ascending from the water was accomplished with a technique advanced by Pelevin and Solomakha that uses at least five spectral measurement channels. This paper analyzed the data obtained in joint, integrated measurements made on 15 April 1988, when the flight path of the Mir station passed over the Los Canareos archipelago and the Batabano Gulf. Mir's track was from southwest to northeast, initially over the Caribbean Sea (over stations to the southeast of Isla de la Juventud), then over the area of the Los Canareos archipelago, with the waters at four points under the flight path studied by Cuban ships virtually simultaneously with the Mir flyover in terms of their optical and biological characteristics. Then Mir passed over the Batabano Gulf, all the way to the coast of the Zapata Peninsula (there were no surface studies there). The researchers concluded that MKS-M technique of atmospheric correction of space-based spectral measurements of brightness is useful for studying the clean waters of the open sea as well as the turbid coastal waters and that the multichannel technique involving the spectrum of the radiation ascending above the sea surface for retrieving the concentration of chlorophyll of the phytoplankton and impurities in the water enables a reliable classification of types of water from their bioproductivity. Figures 4, references 8: 5 Russian, 3 Western.

Seasonal Distribution of Cloud Cover Over Eastern Part of Northern Tropics of Pacific Ocean From Satellite Data

927Q0098E Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 5, Sep-Oct 91 pp 56-60

[Article by V. A. Gashko, I. V. Dremlyug; UDC 528.7:629.78:551.5]

[Abstract] One of the principal factors that hinders monitoring of a water surface from space in the visible range difficult is cloud cover. Results are presented here from an analysis of space-derived information for the cloud conditions of a region of the Pacific on the northern periphery of the intertropical zone of convergence (10-15°N lat, 135-140°W long). The information consists of 357 TV images produced by the Meteor-2 and -3 satellites, as well as from Kosmos-1602. The images were made in 1985 and 1986. Percentage of area covered by clouds is represented on a cloud scale that runs from 0 to 10. The researchers conclude from their analysis that the most favorable periods for monitoring the region in question from space are in March and June, when the mean reading on the cloud scale is 3-4. Seasonal variations in cloud cover are found to be related mainly to

latitudinal variation of the intertropical convergence zone and to a region of elevated pressure in the eastern Pacific, phenomena that are themselves determined by seasonal variations in radiation conditions. The most stable, nearly cloudless weather is observed in the winter-spring period and the summer-fall period. The northern and southern tropical and equatorial zones to the west of a promising minerals-extraction region (145-165°W long, 5°N lat to 5°S lat), as well as the coastal areas of Central America, are the most cloud-free regions of the Pacific. Figures 3, references 4: 3 Russian, 1 Western.

Use of Satellite Radar Surveys to Estimate Intensification of Surface Wind Over Water in Areas of Convective Precipitation

927Q0098F Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 5, Sep-Oct 91 pp 61-69

[Article by M. V. Bukharov, Hydrometeorological Scientific Research Center USSR, Moscow; UDC 551.501:629.78]

[Abstract] The tone of an SLR image of a sea surface can vary with local magnitudes and directions of surface wind as affected by precipitation and with scattering and attenuation of the radar signal produced by the precipitation. The researchers here examined an approach to determining intensities of surface wind based on the use of statistical data on the geometry of scattering layers of precipitation and their link to given cloud systems, as well as on the use of synoptic information on surface winds in areas near the area under analysis. They found that the smaller the θ and φ observation angles, the weaker the effect of scattering on image tone. Even small intensifications of wind, however, are sufficient to compensate for signal attenuation in certain precipitation conditions. The simplest condition for negligible influence of scattering in precipitation consists of radar contrasts ratios of more than two-three and equivalent surface wind velocities (in terms of specific effective scattering area) less than surface wind velocity. Patterns of mesoscale ordering are established for images made by Kosmos-1766 in August and September 1987. Local intensifications of surface wind in the areas imaged are found to stem from wind gusts and squalls caused by downward flows of convective precipitation. Figures 3, references 9: 7 Russian, 2 Western.

Use of Multispectral Space Images for Study of Geology and Environment (As Illustrated by Western Kola Peninsula)

927Q0098G Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 5, Sep-Oct 91 pp 87-91

[Article by M. R. Karputs, V. M. Moralev, L. P. Nilson, D. Roberts, Geology Service of Norway, Trondheim; Institute of Lithosphere, USSR Academy of Science, Moscow; UDC 551.4:528.77+629.77]

[Abstract] The results of the processing and study of multispectral satellite images of the northwestern part of the Kola Peninsula in a Soviet-Norwegian program called the "Norther Region" are presented. The images were produced by the Landsat Thematic Mapper on 18 July 1987, with the spectral intervals of the image channels chosen in such a manner as to avoid atmospheric absorption bands. Two techniques were tested for conversion of images produced digitally: producing images from the more informative of the channels (3,4, and 5), and producing false-color images from the same channels to provide the colors blue, red, and green. The techniques were found to be effective in identifying mining areas whose environment had been subjected to serious anthropogenic effects. The anthropogenic spectral anomalies were, in many cases, more pronounced than spectral contrasts between geological complexes. Figures 5, references 11 (Western).

Research on Macroscale Vortical Flows of Ecologically Dangerous Character in Earth's Atmosphere

927Q0139A Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 1, Jan-Feb 92 (manuscript received 12 May 91) pp 3- 10

[Article by V. D. Zimin, I. N. Klepikov, A. A. Lazarev, S. S. Moiseyev, S. S. Semenov, I. V. Chernyy and Ye. A. Sharkov, Space Research Institute, USSR Academy of Sciences, Moscow; UDC 551.511.61.509.57]

[Abstract] The timely prediction of hurricanes would result in enormous savings in many parts of the world. Specialists at the Space Research Institute, USSR Academy of Sciences, have defined a physical mechanism, specifically, a large-scale vortical aerohydrodynamic dynamo, which will make it possible to predict the generation of a hurricane (typhoon) one-two days in advance. In this mechanism, due to the temperature difference in the atmosphere, small-scale (in comparison with the size of a hurricane) convective cells develop which in a rotating inhomogeneous atmosphere are transformed into "screws" (air flows rising and descending along spirals), from which a large-scale vortex is formed. These and other physical considerations served as the basis for the mathematical theory of generation of a tropical cyclone presented here. It is shown that large-scale structures can be formed under the joint influence of boundaries and small-scale turbulence. Particular attention is given to the amplification of long waves during their interaction with small-scale turbulence, a so-called turbulent-wave dynamo: a simultaneous increase in wave amplitude and turbulent energy due to space and time modulation of the latter by such waves. Continuing research must be directed to the development of methods for remote monitoring of the return cascade of energy in the turbulent atmosphere as a physical process responsible for the appearance and development of large-scale threatening ecological situations of this type. References 16: 12 Russian, 4 Western.

Solution of Problem of Continuous Multiple Coverage of Earth by Artificial Earth Satellite Scanning Swath

927Q0139B Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 1, Jan-Feb 92 (manuscript received 21 Jun 91) pp 62- 71

[Article by B. P. Byrkov and Yu. N. Razumnyy; UDC 629.783]

[Abstract] Ballistic planning of future space systems for study of the Earth's natural resources requires solution of the problem of continuous multiple coverage of the Earth by the scanning swath of an individual artificial earth satellite. In earlier studies research was usually limited to one-time coverage, which did have practical applications, but extension of the geometric constructions for determining the swaths for coverage of a particular zone a multiple number of times, necessary for the analysis and synthesis of systems of satellites with low periodicities, is impracticable. An effective approach has therefore been proposed for finding the minimum width of a swath for multiple coverage of a spherical zone. It is based on an analysis of the nature of coverage of the surface by the scanning swath and derivation of the analytic conditions for continuous coverage of a parallel a stipulated number of times. The pertinent geometric constructions, formulas, theorems and their proofs are given, making it possible to outline a complete solution of the problem. Figures 3; references: 2 Russian.

Results of Research Using Space Photographic Survey for Study of Water-Land Resources of Afghanistan

927Q0139C Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 1, Jan-Feb 92 (manuscript received 10 Apr 91) pp 79- 84

[Article by G. F. Krasnozhon and M. N. Zurmati, Water Problems Institute, USSR Academy of Sciences, Moscow; UDC 528.7.91+551.567]

[Abstract] The first report on research on the water-land resources of Afghanistan carried out after processing of space survey data collected during joint Soviet-Afghan work in August-September 1988 is given. Space photographs at 1:1 000 000-1 500 000 were used. The results are illustrated by survey materials for a part of the Logar River basin. The work demonstrated the good possibilities for use of multiband space photosurveys in the spectral bands 0.6-0.7 and 0.8-0.9 μm in studying the water-land resources of Afghanistan. Interpretation keys were developed for the hydrographic network, irrigated and unirrigated lands. The information yield of different spectral survey ranges was evaluated. More precise and detailed data were obtained on the river network and land resources in the region than when using available topographic maps at 1:100 000. In the future this will make it possible to regionalize the territory of the country with respect to its modern water-land use. False-color or color photographs are the most effective form of information for studying irrigated and unirrigated lands. The considerable areas of irrigated lands and their territorial distribution indicate that in some cases current estimates of water withdrawal for irrigation are too low and water reserves are being incorrectly evaluated. The aerial survey data will make possible more accurate estimates of real water resources. Under the conditions prevailing in Afghanistan survey materials at 1:200 000-1:100 000 should be used. Figure 1; references: 3 Russian.

Report of ESA Contracts With Russian Institutes

927Q0143A Moscow IZVESTIYA in Russian 22 Apr 92 Morning Edition p 6

[Article by Yuriy Kovalenko: "The Fate of the 'Hermes' is in Russian Hands"; the first paragraph is an introduction]

[Text] It appears that there are still fields where enlightened and advanced Europe cannot get by without Russia. Like without our participation it can not construct its "Hermes" shuttle.

The European Space Agency (ESA) has signed contracts with scientific research institutes and enterprises of the former Soviet Union. They must propose to the Europeans technological solutions for problems which the ESA is in no position to solve independently.

It is true that for the time being Russian specialists have been asked to carry out only preliminary research. However that may be, the governments of 13 countries which are ESA members have authorized the agency to turn to Russia for cooperation and to allocate 35 million francs for payment for our services during the next half-year. This is the first contract, notes the newspaper FIGARO, providing for the transfer of the latest technology from the East to the West. The ESA is interested in about 50 fields of scientific and technical cooperation with the use of Russian "know-how." The assistance of Russian enterprises, emphasizes FIGARO, will enable Western companies not only to overcome technical difficulties involved in the "Hermes" project, but also more rapidly and with lesser expenditures implement other civilian and military programs.

A highly important project of Russian-European cooperation, in all likelihood, will be development of a system for thermal shielding of the "Hermes." Initially the ESA intended to construct the ship entirely from composite materials capable of withstanding a temperature up to 1500 degrees. However, the agency had to desist from this idea due to the excessive increase in the ship's weight and its cost. And then the West, writes FIGARO, to its great surprise recently discovered that the composite materials which we had developed were both light and reliable.

In addition, Russia, from the point of view of ESA experts, also can assist in such fields as aerodynamics, modeling of the Earth's atmosphere and computation of the flight trajectory. Despite the inadequate availability of computers, writes FIGARO, Russian engineers have at their disposal unique theoretical knowledge and experience the equal of which does not exist in the Old World.

Europe also has turned to Russia with a request to submit proposals relating to the training of cosmonauts both for flights and for emergence into open space and also proposals on their spacesuits and ejection seats. According to some estimates, the use of our experience will make it possible to save the ESA several billions in the "Hermes" budget, which is 55 billion francs. Among many specialists there is talk of one of the last chances for saving the entire "Hermes" program, which in the opinion of some countries is too costly.

Group Considers Ways to Develop Space Program in Ukraine

927Q0106 Kiev NARODNAYA ARMIYA in Russian 4 Mar 92 p 3

[Article by Maj Gennadiy Klyuchikov: "A Ukrainian Crew in Space? It's a Reality, Declares the Ukraina-Kosmos Society"; first paragraph is source introduction]

[Text] **"Ukraine must become a nuclear-free nation"—one of the first declarations that the new power made to the entire world. And to a large extent, that fostered recognition of it in the international arena.**

Today, the process of disarming has taken on entirely real forms. What lies ahead is broad-based, varied work. What does Ukraine bring with it when it begins that path? Here's just one fact: the 176 strategic objects on the territory of our state indicate what an abyss we're standing over. That's 176 potential Chernobyls and Hiroshimas. But it's also 176 chances to change our minds and save our descendants.

It's noteworthy that the first and most vigorous supporters of the use of that chance are the Ukrainian people. Numerous social organizations are coming together and pooling their capital. Even now, the process is under way for the creation of a unique coordinating agency—the Center for Nuclear Safety, whose purpose is to do what it takes to demilitarize the economy and to channel the science potential we have into a peaceful direction.

All 176 of those most destructive of missiles must become the most peaceful, unclassified objects. It has been suggested that tourist centers be created at the missile silos, or perhaps museums of former intercontinental nuclear bases, so that our children can regard and perceive nuclear weapons as museum exhibits only.

The Ukraina-Kosmos Society has been called upon to play a special role in this. The society was created in December 1991 as an independent organization whose purpose consists in the ideological, informational, and commercial support of Ukraine's space program. The members of that society are renowned, solid organizations such as the Ukrainian Peace Council, the Ukrainian Academy of Sciences, the National Bank of Ukraine, the Doveriye firm, and the Kiev Youth Aerospace Association Vselennaya.

Among its priorities, the society plans to arrange for the flight of a Ukrainian crew into space, carry out the Kosmos-Detyam program [Space for Children], promote

Ukraine as a space power, compile an ecological map of Ukraine, and collect data on the effects of the Chernobyl disaster.

At a recently held press conference, Sergey Burlachenko, the vice-president of the joint-stock company Neizvestnyy Kosmodrom [Unknown Cosmodrome], spoke about how further activity of the Ukraina-Kosmos Society is being viewed, on what human values the society is based, and what its capabilities are.

"Space doesn't have to be an arena of struggle," Sergey Borisovich [Burlachenko] emphasized. "And the activity of the Ukraina-Kosmos Society fully meets the peaceful interests of our young, independent state. History is giving us a chance—free Ukraine of nuclear paths, channel its enormous science and production potential for peaceful purposes. And if our people today are not as active and unified as possible in the matter, then none of us will solve the problem."

The constructive position and noble goals of the organizers of the press conference were beyond doubt. But the plans of the Ukraina-Kosmos Society were subjected to intense scrutiny by the specialists present at the meeting.

In the context of his own personal point of view, V. Gorbulin, the chief of the subdepartment of the defense industry of the Ukrainian Cabinet of Ministers, expressed doubt that it would be possible or advisable to undertake such broad-based projects as putting a crew into space or purchasing strategic missile silos. And even if they are very rich organizations, they are still public organizations. And such matters are more within the capability of a strong [state] power.

The support of space research is another matter. Now, with the collapse of the former USSR, the Ukrainian science that is conducting the study of space and is developing new models of rockets needs the moral and financial support of all the people badly.

And about the missile silos. The operation itself of removing the warheads from the missiles is extremely complicated and dangerous. Even the United States, in proposing financial aid, has no pretensions about actually helping in the removal of the warheads. The disassembly of the silos also requires complex engineering operations.

That opinion was supported by the director of the Main Astronomical Observatory of the Ukrainian Academy of Sciences, Academician Ya. Yatskiv. In his view, the idea of sending a Ukrainian crew into space is clearly premature. And the problem is not even that it's a very expensive amusement. It costs $12 million, for example, to ready one cosmonaut. It cost 400 million rubles to launch a Fobos, and one launch was unsuccessful.

Yatskiv feels that today we need to focus all our efforts and monies on long-term space research. Ukraine needs to learn to be patient in its conduct of scientific research in that area. Spaceflights [manned] are not our goal for now. They aren't of any benefit. Space research is much more important and beneficial.

But a representative of the Kiev Council took exception to what the scientists said, and he stressed that public organizations are not design bureaus. They represent public opinion and strive to attract as many people as possible to given purpose. Moreover, any idea can be knocked down if everything is put into a pragmatic plane and called a problem.

That same thought was underscored by a representative of the Doveriye firm. The organization is not about to launch space rockets with crews itself. Its business is to provide ideological support of our state's space program. We are ready to support scientific research, which is in a lamentable state today, and to promote advanced space development projects.

Despite the heated debates that flared up during the press conference, they were far from a confrontation. Positions were laid out, and specific points of application of efforts and finances were outlined. And that was the constructive part of the whole thing.

As a result, a common denominator was found. The press-conference participants unanimously noted that Ukraine is in fact a space power. After all, it's in Dnepropetrovsk that more than 200 satellites have been developed. And the best rockets in the world are made there. And Kharkov creates all the electronic insides of space rockets. So we do have a base.

However, with former economic ties broken, space research is threatened with shut-down. In a matter of months, we could lost the space potential that has taken decades to build up. Putting an end to the withering process, explaining to the people that today's concerns about the daily bread shouldn't prevail over the future of the country—those are the things that represent the main job of the public organizations. Space research isn't conversion. Yes, it's expensive. But we have to remember that the path to a civilized society is through space.

Foreign Minister Says Ukraine Has Resources to Become Space Power

PM1604124892 Moscow IZVESTIYA in Russian 16 Apr 92 Morning Edition p 1

[Sergey Tsikora report: "Ukraine Intends To Become Space Power"]

[Excerpt] Two news conferences have been held in Kiev, giving us a better understanding of the positions and current relations between Ukraine and Russia. Metropolitan Filaret, head of the Ukrainian Orthodox Church, and Ukrainian Foreign Minister A. Zlenko met with journalists.

The head of the republic's foreign policy department issued a sensational statement. When asked what Ukraine is thinking of doing with the vast strategic delivery vehicles which are developed at its plants but do not come under the international treaties, A. Zlenko replied:

"These are Ukrainian property and we are entitled to dispose of them as we see fit. For the time being these missiles are being stored. But we already have plenty of ideas regarding their use. Ukraine did a great deal to open up space for the former USSR. We have the specialists and the resources to become a space power and derive the benefits from the use of space and space technologies."

The Ukrainian foreign minister also set out in detail the republic's proposal as regards the withdrawal of tactical nuclear weapons to Russia. He described the new mechanism for interstate supervision [kontrol]. The key idea is that Ukraine take a direct part in withdrawing and supervising the destruction of the weapons. [passage omitted]

Head of Ukrainian Space Agency's Interviews With Cosmonauts, Scientists

927Q0142 Kiev PRAVDA UKRAINY in Russian 11 Apr 92 p 2

[Interview with cosmonauts German Stepanovich Titov, Pavel Romanovich Popovich, and Aleksey Stanislavovich Yeliseyev and Energiya system chief designer Boris Ivanovich Gubanov and NPO Energiya general designer Yuriy Pavlovich Semenov by Ukrainian Space Agency head Vladimir Pavlovich Gorbulin; article prepared by Tamara Mayboroda, under the rubric "Tomorrow, Space Program Day": "...And on Mars the Apple Trees Will Bloom"; first two paragraphs are source introduction]

[Text] **That line ["...and on Mars the Apple Trees Will Bloom"] is from a song in the optimistic, all-powerful "sixties," and mankind's dream has yet to be realized. But who knows, maybe it will be. After all, in the three decades that have gone by since man's first flight into space, so much has been done, so many landmarks have been put up along the way to understanding the Universe.**

In a joint discussion of that with several "space" figures, V. P. Gorbulin, the general director of the Ukraine's national space agency, served as a sort of moderator. The fact is that Vladimir Pavlovich [Gorbulin], in the performance of his official duties is no stranger to the space program and has rubbed elbows with pilot-cosmonauts, with hardware developers, with engineer*researchers, and with scientists. The result of those encounters is the recently published book "Zvezdnoye prityazheniye" [The Pull of the Stars] (dialogues about the space program).

Question to the No 2 cosmonaut of the planet, G. S. Titov:

GORBULIN: For you, German Stepanovich, the avenues into the space program were two: first, into the cosmonaut corps; and then when, after receiving a higher military and engineering education, you began developing and building space hardware. Which was more-complex?

TITOV: What was more complex, where was it more difficult? It's probably hard anytime your work constitutes the primary meaning of your life, especially when it is, as they say, unlike any other in the world. Things are difficult, but very interesting. I must say that being involved in the development, building, make-ready, and launch of space vehicles and controlling those vehicles as they fly hundreds of millions of kilometers away is no less interesting than actually being in space.

Question to pilot-cosmonaut P. R. Popovich:

GORBULIN: Pavel Romanovich, you have spoken a great deal about space-based studies of the Earth and about how the space program is fulfilling the orders of various sectors of the national economy. But many of the reports made by cosmonaut crews from aboard orbital complexes are not only about that work, but also about the performance of various scientific-research experiments. At first glance, they don't seem to have any direct connection with what's going on here, with our "Earth-bound" lives. Is that so? What is the purpose of such experiments?

POPOVICH: The program of every space mission is thought out to the smallest detail. Believe me, cosmonauts don't get bored in orbit. Scientists and specialists are interested in a great many questions whose answers are hard, if not impossible, to find on the ground. Which is why a program contains a variety of experiments whose results are anxiously awaited on the ground. For example, several years ago, aboard the Salyut-6 station, materials with specific properties were produced with the Splav electric-heating unit.

Question to pilot-cosmonaut A. S. Yeliseyev:

GORBULIN: Aleksey Stanislavovich, increasingly, orbital stations are becoming scientific-technical laboratories. What, in your opinion, does the cosmonaut-researcher need for successful work in orbit?

YELISEYEV: The requirements for the work of the flight engineer and the engineer-researcher aboard space stations are constantly growing. There are two trends at present. First, the amount of scientific-research work is increasing sharply in space. Second, the experiments being performed are becoming more profound and complex. Such work can be done by highly qualified specialists only—preferably, specialists with a broad range of skills.

Question to the chief designer of the Energiya rocket-space system, B. I. Gubanov:

GORBULIN: The creation of the Energiya-Buran system involved the use of the newest achievements of

science and technology, most of which have no analogs the world space sector. Boris Ivanovich, can that system play a definite role in implementing ideas involving the creation of settlements on the Moon and the landing of a man on Mars? How do you feel, personally, about those projects?

GUBANOV: The plan to land a mission on Mars strikes the imagination with its boldness and, as paradoxical as it may seem, with its urgency for today.

Studies show that our reserves of metals, gases, and other minerals are being depleted here on Earth; but they exist in large quantities on celestial bodies—the neighbors to our planet. On Mars alone, for example, we have detected magnesium, sulfur, silicon, titanium, and iron.

However, it must be kept in mind that organizing and readying an international mission will be extremely expensive in material terms and is hardly doable by any one country alone. As for the technical aspects of the problem, a number of questions must be resolved.

It will be relatively simple to base the creation of a booster capable of delivering up to several tons of large-scale payload to near-Earth orbit on the Energiya system.

Questions to NPO Energiya general designer Yu. P. Semenov:

GORBULIN: Yuriy Pavlovich, what do you think the orbital complexes of the future will be like?

SEMENOV: The complex of the future will be a consolidated system of large structures linked to one another. Earth-orbit transportation will be provided by cargo/passenger transports that will include reusable craft. The complex will have specialized research laboratories, comfortable living quarters, greenhouses, powerful energy sources, fueling stations, repair shops....

Such an orbital complex, even in the initial stages of its creation, will enable a country to constantly monitor the state of the atmosphere and crop fields and to increase the efficiency of prospecting and the level of mineral reserves.

The complex will provide the industrial production of a number of electronic, optical, and biomedical materials and preparations with characteristics unachievable on the ground.

GORBULIN: What part are the scientists of Ukraine playing in space research?

SEMENOV: Many science groups of the republic are making an invaluable contribution to the creation of manned spacecraft and stations. Ukrainian scientists are also playing an important role in solving materials-science problems associated with space hardware. For example, the Ukrainian Academy of Sciences Institute of Physics developed the Elektrotopograf instrument for studying the degradation kinetics of structural materials and coatings subjected to the combined factors of space.

Scientists of the Kharkov Polytechnic Institute have developed the basic tenets of a technique for accelerating tests of structural materials in open space.

A special role is being played by scientists of the Ye. O. Paton Institute of Electric Welding in the development of space hardware and technology...

[Epilogue]

Ukraine—A Space Power

A conversation about that topic will follow at a later date, when V. P. Gorbulin feels that the national space agency, which is taking only its first organizational steps, is more or less sure on its feet.

So we look forward to that.

Azerbaijan Air and Space Agency Created

925D0295B Baku BAKINSKIY RABOCHIY in Russian 22 Feb 92 p 1

[Ukase by the President of the Azerbaijan Republic: "On Creating an Azerbaijan National Air and Space Agency"]

[Text] In order to implement state policy in the sphere of mastering space, develop and carry out national aerospace programs, coordinate and administer operations with regard to international space projects jointly with other states, as well as effectively utilize existing scientific and production potentials in these sectors in the interests of the national economy and security of this republic, **I hereby decree the following:**

1. The Azerbaijan National Air and Space Agency (ANAKA) shall be created, based on the scientific and production association for space research.

2. The Azerbaijan National Air and Space Agency shall be subordinate in its activity to the president of the Azerbaijan Republic.

3. The principal tasks of the Azerbaijan National Air and Space Agency shall be the following:

forming a national scientific and technological policy in the field of mastering space, organizing, administering, and coordinating basic and applied research being conducted in this field within our republic, developing aviation and space equipment;

working out and implementing the concept of international cooperation in utilizing space in the interests of the national economy, joint interstate aerospace programs, plans and agreements, as well as bringing aerospace services out onto the world market;

training and retraining highly skilled specialists in the appropriate branches of aerospace science and technology.

4. Mekhtiyev, Arif Shafayat ogly shall be appointed as general director of the Azerbaijan National Air and Space Agency.

5. Within a month's time the general director of the Azerbaijan National Air and Space Agency shall work out and submit a draft statute for this agency, along with proposals concerning its numerical strength.

6. The Azerbaijan Republic's Cabinet of Ministers shall resolve issues regarding this agency's financial and economic provisions.

7. The present Ukase shall go into effect the moment it is published.

[Signed] A. Mutalibov, president of the Azerbaijan Republic

Baku, 21 February 1992

Commonwealth National Space Agencies Approve Regulations

LD2404230592 Moscow ITAR-TASS World Service in Russian 1655 GMT 22 Apr 92

[Text] Moscow, 22 Apr (ITAR-TASS)—A package of documents regulating activity in space and the procedure for using space infrastructure in the interests of the countries of the Commonwealth for examination and approval at a routine meeting of the CIS heads of government was elaborated at the conference of leaders of the national space agencies and of experts of Azerbaijan, Byelarus, Kazakhstan, Kyrgyzstan, Moldova, the Russian Federation, Tajikistan, Uzbekistan, and Ukraine and also of representatives of the strategic forces, which took place here on 20-22 April.

Conference participants confirmed the need for the efforts of Commonwealth states to be united in space activity.

Satellite Launch, Yeltsin Visit Postponed

LD2204072492 Moscow ITAR-TASS World Service in Russian 0706 GMT 22 Apr 92

[By ITAR-TASS special correspondent Yuriy Konorov]

[Text] Plesetsk Cosmodrome, 22 Apr—The launch of the artificial earth satellite in the series "Resurs F-2" planned for 23 April has been postponed. An ITAR-TASS correspondent was told by specialists at the Plesetsk Cosmodrome that owing to difficulties connected with ensuring the safety of people living in the zones where the third stage of the carrier-rocket was due to fall, the launching of the satellite could not be carried out earlier than 29 April. The visit by Russian President Boris Yeltsin to the northern cosmodrome which had been timed for the launching of the satellite has also been postponed.

Yeltsin Plesetsk Visit, Satellite Launch Delayed

LD2504154292 Moscow Mayak Radio Network in Russian 2100 GMT 24 Apr 92

[Text] The planned launch of the Resurs-2 satellite has been postponed at the Russian space launch complex of Plesetsk. Space vehicles of this series film the Earth in the interests of geologists, farmers, and environment protection specialists. According to representatives of the military command of the space launch complex the postponement of the launch of the satellite to a later date was caused by technical reasons, in particular, by the failure of one of the systems of the Soyuz carrier rocket. It has become known at the same time that Boris Yeltsin's trip here has also been postponed. His future visit is connected with overdue political decisions on making this space launch complex Russia's main space port. The technical facilities that exist here make possible the launching of not just satellites for national economy purposes from here but also manned spacecraft.

Yeltsin Attends Satellite Launch at Plesetsk

LD2904095792 Moscow ITAR-TASS World Service in Russian 0925 GMT 29 Apr 92

[Text] Moscow, 29 Apr (ITAR-TASS)—The spacecraft "Resurs F-2," intended for economic purposes, was launched today from the Plesetsk launching site in Arkhangelsk Oblast. The ITAR-TASS correspondent was informed at the space units command of the CIS Joint Armed Forces that Boris Yeltsin, president of the Russian Federation, was present at the launch.

Yeltsin Visit to Plesetsk Cosmodrome

Cosmodrome Status Discussed

PM2904114592 Moscow KRASNAYA ZVEZDA in Russian 29 Apr 92 p 1

[Report by Colonel A. Belousov and Major A. Dolinin: "Could Plesetsk Become the Central Russian Cosmodrome"]

[Text] Arkhangelsk, Severodvinsk, Mirnyy, and Cherepovets make up the itinerary of the working visit to the northern cities of Russia by Russian Federation President Boris Nikolayevich Yeltsin which began 28 April.

That evening the president arrived at the Plesetsk cosmodrome in Mirnyy. This part of the tour is arousing special interest among the numerous representatives of the press who have gathered here.

The Plesetsk cosmodrome is not called a workhorse for nothing. Marshal of Artillery M.I. Nedelin was involved in its inception. The Cosmos-112 spacecraft was

launched from here in March 1966. And since then spacecraft have been launched into orbit every year, month on month. It accounts for around 60 percent of all launches in the country. The series of Cosmos and Intercosmos satellites and the "Araks," "Porcupine," "Apex," and other missile programs have enabled scientists to carry out unique experiments in the sphere of space research and utilization for peaceful purposes. But manned spacecraft have never been launched from here. And journalists have been conjecturing that Plesetsk might be given the status of Russia's number one cosmodrome, from where manned spacecraft might also be launched.

However, in conversation with representatives of the president's administration your KRASNAYA ZVEZDA correspondent ascertained that such conjecture is clearly premature. Boris Nikolayevich Yeltsin's work at the cosmodrome will be primarily that of familiarization, although the possibility of specific decisions being made regarding the northern cosmodrome cannot be ruled out.

The following is the opinion of Yuriy Nikolayevich Koptev, director of the Russian Space Agency:

"There is no point in raising the question of granting Plesetsk the status of the central Russian cosmodrome, one capable of replacing Baykonur, in the next five to six years. This is improper and unrealistic in view of the large costs and capital investments involved. Moreover, Baykonur alone is capable of delivering all kinds of payloads into geostationary orbit. Basic human practical sense and reason make you realise that if Baykonur is abandoned it will turn into a scrap metal dump. Kazakhstan does not have its own autonomous space and missile potential."

An agreement on space infrastructure was initialed by eight CIS states this week; it has been prepared for signing by CIS heads of state in Tashkent.

As far as the Plesetsk cosmodrome is concerned, it is intended to expand its activity in the light of certain advantages it has over Baykonur. The trends of upcoming space programs and the wishes and plans of Russia presuppose the further development of both Baykonur and Plesetsk.

It is expected that a meeting will take place in the garrison Officers' Club between the president and the inhabitants of the camp on the morning of 29 April; the president will then visit the block where spacecraft and delivery vehicles are assembled and tested, inspect mobile missile systems, and observe the launch of a "Resurs F-2" spacecraft, which is intended for national economic purposes. In the afternoon Yeltsin will leave for the city of Cherepovets. During his tour the Russian president is accompanied by Yuriy Skokov, secretary of the Security Council; Mikhail Maley, state adviser; Viktor Ilyushin, leader of the president's secretariat; and Vasiliy Barchuk, Russian Federation finance minister. Marshal of Aviation Yevgeniy Shaposhnikov, commander in chief of the CIS Joint Armed Forces; Andrey Kokoshin, Russian Federation first deputy defense minister; Army General Yuriy Maksimov, commander of the CIS Joint Armed Forces Strategic Forces; Colonel General Vladimir Ivanov, chief of space systems; and other military chiefs and officials also visited Plesetsk.

Discusses Space Cooperation With Kazakhstan

LD2904220192 Moscow Teleradiokompaniya Ostankino Television First Program Network in Russian 1700 GMT 29 Apr 92

[From the "Novosti" newscast]

[Text] The center of Russian politics moved to the north today, to Arkhangelsk Oblast, where there is land that has been Russian from time immemorial. The Northern Fleet is there, too, as is the military-industrial complex. So Big Politics is there too. [video shows large limousine bearing a Russian flag passing over a train crossing]

[Voice-over by correspondent S. Slipchenko] The first thing the Russian president noticed in Mirnyy was the roads. Probably none of the big chiefs has come here for a long time, Yeltsin observed, although the roads had been covered with gravel the day before. [video shows Yeltsin emerging from the car]

During the rocket engineers' launch preparations, thousands of people gathered around the memorial dedicated to those who have died. There were flowers, the national anthem, and handshakes. [video shows Yeltsin and military officers laying wreaths]

On the next day journalists had virtually nothing to do. The three installations that Yeltsin was touring are the kind that are closed to the press, so we came here, to the launch pad, where the Resurs-2 satellite was being prepared for blast-off. [video shows rocket on launch pad]

A tragedy occurred on this very launch pad; in 1980, 57 people died here. President Yeltsin laid flowers at the site. We are gradually finding out about all the pages of space exploration, not just the bright ones.

The president arrived a few minutes before the launch. [video shows Yeltsin talking to correspondents]

[Begin recording] [Slipchenko] Does that mean that this place, Defense Ministry Test Site 53, will nevertheless be a cosmodrome, a Russian cosmodrome?

[Yeltsin] To make a real Russian cosmodrome here and to tackle the problems that are tackled at Baykonur but are not tackled here, some 10 billion rubles would have to be invested. At the moment, we are....

[Slipchenko, interrupting] Not ready.

[Yeltsin] Not ready. Not ready for that. Maybe later, when the economic atmosphere, the situation is better. There is a need to think it over. There are certain

technical points here, since Baykonur is closer to the equator. Although, on the other hand, a number of points are, on the contrary, even....

[Slipchenko, interrupting] Better here.

[Yeltsin] Better here, since there is the northern angle of inclination and so on. So it does have its advantages, as it were. The site was not chosen fortuitously, of course, and in general the level of the equipment is high. We need to decide about Baykonur, though. Yesterday a satellite launch was stopped at Baykonur—our satellite for the military and the military of the CIS Joint Armed Forces, not just for Russia. It is our joint mission. But Kazakhstan has started to act up a little. They want to show that we need to have some kind of agreement between Russia and Kazakhstan on Baykonur. When I meet Nazarbayev on 15 May in Tashkent we will, of course, discuss the matter thoroughly. What will it be? We could have some kind of joint enterprise, or we can buy some part of the property, or share the financing. We (?would like) any suitable option.

[Slipchenko] A joint one?

[Yeltsin] Yes, a joint one. [end recording] [video shows rocket blasting off; Yeltsin is seen peering through binoculars, flanked by Air Force and Army officers]

[Slipchenko] Resurs-2 took nine minutes to go into orbit. After that the president continued to inspect the military hardware. According to experts, there was much that was new to him. President Yeltsin set off for Cherepovets in the afternoon.

Space Research Secrecy Lifted

LD3004092992 Moscow Teleradiokompaniya Ostankino Television First Program Network in Russian 0800 GMT 30 Apr 92

[Text] Boris Yeltsin is continuing his trip to Russia's northern towns. He is currently in Cherepovets. Yesterday, he attended satellite launches at Plesetsk. Commenting on the conflict over the country's main cosmodrome, Baykonur, the president noted that the issue will be discussed on in Tashkent on 15 May and stressed that Russia is prepared for any suitable option.

Boris Yeltsin also stated that he had signed a decree lifting the seal of secrecy on 30 categories of space research issues.

Question of Shifting Space Launch Operations From Baykonur to Plesetsk Discussed

Key Issues Remain Unanalyzed

927Q0160A Moscow NEZAVISIMAYA GAZETA in Russian 29 Apr 92 p 6

[Article by Yuriy Meshkov, reported from Plesetsk and Moscow, under the rubric "Space Program": "Cosmodrome at Plesetsk Could Become Russian Baykonur"; first paragraph is source introduction]

[Text] **They've been waiting for Yeltsin here for two weeks. The launch of the next satellite is slated for today.**

The demands of Kazakhstan for the payment of billions of rubles for the lease of the Baykonur land that is within the borders of the contiguous sovereign state have brought the issue of an alternative to Baykonur to a head. The gazes of scientists, engineers, and politicians have turned to the northern cosmodrome in Arkhangelsk Oblast near the settlement of Plesetsk. The strategic facility, only recently still top secret and, ironically enough, named Mirnyy [Peaceful] during the cold war, is actually laying claim to the switch today. But such a step entails rather large material outlays, the true size of which, I think, few people are aware of.

That thought came to mind during my recent acquaintance with the northern cosmodrome, where I arrived on the eve of the launch of the next national-economy-related satellite, Resurs-F2. Meetings with military and civilian specialists convinced me that neither they nor anybody else can reliably conjecture about today's—much less tomorrow's—expenditures on the space program. Even if one wanted to, it would be very difficult to estimate even roughly what the profits would be from the operation of any given space vehicle—there aren't any techniques for that or, generally speaking, the desire to do it. The question of revenues and expenditures before now have never affected our many military and semimilitary space departments directly. Consequently, they never involved themselves with economics on the proper professional level. A willful style of management reigned over everything. And it still does. An example of that is Boris Yeltsin's visit to the northern cosmodrome, awaited since 15 April. But if, despite the absence of the president, the space facility went into orbit on 15 April right on schedule, as they say, the launch of the Resurs slated for 23 April was postponed. It's hard to say what, exactly, was the main reason for the transfer of the launch date. The official version is a technical problem in the control system, and only after that, as a result, the absence of Yeltsin at the launch facility. However, the course of events in Mirnyy and the atmosphere in which the launch is being readied—by the way, in the commander's circles of the test range, the launch has already been dubbed "Yeltsin's" or "the president's"—gives reason to doubt the sequence of the cause-and-effect relationships. It's strange, for example, that even a member of the State Commission who represents the interests of the State Priroda Center—the main client of the forthcoming flight—knew nothing about the "technical reasons" for the delay. My question about when they would be able to eliminate the problem they found was met with the absolutely sincere surprise of the State Commission member: "What problem? It's just that Yeltsin isn't coming yet—so they transferred the launch date...."

Whatever the truth is, there are big hopes tied to the visit by the president of Russia. As soon as Plesetsk is ready to accept the load from Baykonur, a multitude of vitally

important problems will have to be solved immediately—from the financing of operations for the re-outfitting of the launch complexes to the appending to the space facility of the status of Russia's cosmodrome. That decision is awaited from day to day. But why aren't they in a hurry?

In the opinion of the specialists with whom I had occasion to speak at the cosmodrome, a balanced analysis of all the consequences of moving the Baykonur cosmodrome to Plesetsk has hardly been done to date. And they don't know anything about the economic side of things. It's more like, such calculations simply don't exist. And anyway, the desire alone to rid themselves a little more quickly of the growing pressure being applied by Kazakhstan authorities on Baykonur is not enough. There are at least several problems without whose solution nobody can seriously talk about moving the cosmodrome. First, the geographical location of Plesetsk. It is such that the trajectory of an ascending space vehicle unavoidably passes through the powerful radiation belts of the Earth. That has not been of any importance until now, because no manned launches have been done from Plesetsk. But now, to avoid exposing the cosmonauts to the dangerous effects of radiation, either the orbital injection trajectory must be adjusted or an additional biological shielding for the spacecraft must be created. Either one means additional outlays, and, it must be said, they won't be small.

There's another problem that requires more attention—the regional ecology. As it is, that's a not-so-simple issue in terms of the relationship between the workers of the cosmodrome and the local population. True, it's possible that the fears of some and the optimism of others are seriously exaggerated. That's apparently because the ecological information on the cosmodrome and its effect on the environment is extremely spotty. No serious studies have been done yet. But they are needed if only because the opposition will only grow without reliable information.

And there are other reasons to thoughtfully weigh out all the pros and cons with regard to the northern cosmodrome **before** making a decision about its fate, and not **after,** as, unfortunately, is most often the case. The situation is such that without a competent economic and ecological analysis of the consequences of moving the southern cosmodrome to the north, the political mess between the two former brother republics could be very expensive to us.

For two weeks now already, the sounds of shovels and iron bars have not left the streets of Mirnyy. Through the efforts of a good many soldiers, the city is being cleaned of snow and ice—they're awaiting the president. The assembly-and-testing buildings at the launch pads are shining with a fresh coat of paint and are fragrant with aromas that are far from those of spring—they're awaiting the president. Standing on the pad for the ninth day is the launch vehicle with the Resurs-F2 satellite, whose information is awaited by geologists, cartographers, and ecologists. But the satellite is waiting for the president.

Yeltsin Favors Agreement With Kazakhstan

927Q0160B Moscow NEZAVISIMAYA GAZETA in Russian 30 Apr 92 p 1

[Article by Tatyana Malkina: "Satellite is Launched, Yeltsin in Cherepovets"]

[Text] Yesterday, Boris Yeltsin attended the launch of the Russian satellite, Resurs-F2, from the cosmodrome/test range at Plesetsk. The launch cost 50 million rubles in 1991 prices and was the 247th launch from Plesetsk. After the launch, Yeltsin had a meeting with the "space leadership."

One the main questions associated with the test range is, can Plesetsk, which is not outfitted for launching manned spacecraft, become an equivalent replacement of Baykonur. After all, Kazakhstan, as we know, has laid claim to the only "full-fledged" cosmodrome of the former USSR. By the way, by strange coincidence, the day that Yeltsin arrived in Arkhangelsk, the launch of a Russian satellite at Baykonur was not allowed.

"Our Kazakhstan friends are a little capricious," the Russian president said. He noted further: "The course of the development of events shows that an agreement between Russia and Kazakhstan on Baykonur is needed.... What will it consist of—a joint venture, or maybe we could purchase some part of the property, or even separately finance Baykonur? We're open to any reasonable idea."

As for Plesetsk, Yeltsin said this: "To make a real Russian cosmodrome here...takes about 10 billion rubles of investments. Right now, of course, we're not ready for that." At the same time, he suggested moving some of the Baykonur programs to Plesetsk, although he did add: "But that will happen gradually, not in a year, not even in two years."

Yesterday evening, the president of Russia went to Cherepovets.

Russian-Kazakh Agreement on Baykonur Viewed

LD0305091492 Moscow Teleradiokompaniya Ostankino Television First Program Network in Russian 2010 GMT 30 Apr 92

[From the "Novosti" newscast]

[Text] Yesterday Boris Yeltsin visited Plesetsk Cosmodrome which evidently is to become a real Russian cosmodrome, according to the president. The thing is that Nursultan Nazarbayev, Kazakhstan president, has given to understand that Baykonur Cosmodrome should not be a launch pad for either military or space rockets. In this regard alterations to our space policy are possible.

[Correspondent P. Fil] Soviet rockets were launched into space from two main cosmodromes: Baykonur in Kazakhstan and Plesetsk in Russia. Where will CIS space rockets set off from? Visiting the Plesetsk launch pad Boris Yeltsin spoke in favor of its further development, mentioning that large amounts of money are necessary for this. However in the opinion of specialists...

[Yu. Melov, deputy director of the Russian Space Agency] ...the number that was mentioned, in the area of 10 billion rubles, this of course is a minimum figure. And if a cosmodrome is to be developed sufficiently well there, then with this the costs will grow accordingly.

[Fil] The fate of the former Union's main cosmic range, Baykonur, is not clear, at least not until Russia and Kazakhstan agree on the procedure for using it. It is necessary like air, it is necessary for everyone. If Kazakhstan announces that Baykonur belongs to it on purely territorial grounds, then it will turn into a dying stone jungle in the middle of the desert needed by no one. Only rockets of a certain type produced only in the CIS can launch from here. And therefore one of the proposed ways out—the hiring out of launch pads to third party countries—is completely ruled out. Kazakhstan will not have its own rockets for a long time, for a whole number of reasons.

What will the possible loss of Baykonur bring to Russia and CIS cosmonautry as a whole? Booster rockets of the Proton type will cease to fly into space, they take off only from Baykonur, and therefore the road for cargoes for the orbital station will be closed. It will be necessary to abandon the station itself. The more or less important launches from Plesetsk, which is much further than Baykonur from the most convenient place for space launches—the equator—will demand such energy expenditure that it will simply be disadvantageous to deliver cargoes into orbit. In a word, if Kazakhstan and Russia do not agree then along the way there will only be problems, and the constant development of cosmonautry will slow down.

[Melov] There is only one way out: a way out via political decisions. An agreement must be signed between Russia and Kazakhstan. We are preparing such a document just now and on the 15th, at the Tashkent meeting, we will give our president, together with Nazarbayev, the possibility of signing this document.

Chief of Plesetsk Cosmodrome Interviewed

927Q0082A Moscow PATRIOT in Russian
No 7, Feb 92 p 5

[Interview with Col. A. F. Ovchinnikov, chief of Plesetsk cosmodrome, by Vladimir Bokan: "A Cosmodrome is Not a Harmful Neighbor"; the first paragraph is an introduction; the second paragraph is a brief familiarization with Col. A. F. Ovchinnikov]

[Text] Recently much is being written about how the presence of large military space installations exert an influence on one region or another. We hear of Baykonur, Semipalatinsk and Novaya Zemlya. But not so much is known about the Plesetsk cosmodrome, located in Arkhangelsk Oblast, although this is a very large installation actively working both for "defense" and for the economy. The series of "Resurs" economic satellites is launched from here. Our special correspondent, the Arkhangelsk journalist Vladimir Bokan, visited the cosmodrome.

Colonel Anatoliy Fedorovich Ovchinnikov is the chief of the space center at the Plesetsk cosmodrome. He is no newcomer to the Arkhangelsk region. He was born here, in Plesetsk Rayon and also graduated from school here. His father during his entire life worked in the local timber industry and is now retired, living in Novodvinsk.

"In general," states the colonel, "without stretching things it can be said that I am one of you."

"Ah, one of us!" I said, latching onto the last phrase. "Then we can talk like fellow countrymen. In fact, you probably have something to say without waiting for questions."

"Two matters," responds Anatoliy Fedorovich without giving it much thought. "First, with respect to the campaign going on in the oblast for making the cosmodrome allocate sums to the local budget. All those who are writing about and discussing this matter have a too aggressive attitude toward us. They say that we have 'bitten off' a big chunk of territory in the oblast and are guilty of all kinds of lawlessness without paying a cent for the damage done. As if every officer, every worker of ours, had illegally appropriated to himself a hectare of forest, for which he also must answer...

"No, we are not against paying, but the money must be 'dug up' from the government, not from us. I would like for my fellow countrymen to understand that the cosmodrome is an organization financed from the national budget and in our expenditures there is simply no provision for allocations to the local budget. Or do people thing that we have money to burn? Look at our roads! Yes, they are concrete. But they were constructed thirty years ago and they have not been repaired once since then. We do not have the financial resources for even that.

"And second, what they write about our 'murderous impact' on regional ecology.

"The rumors that we are ruining the environment throughout the whole of the European North of the country, as they say, are greatly exaggerated. It is true that during the launchings of space vehicles into the atmosphere a definite quantity of uncombusted aggressive components of rocket fuel is discharged into the atmosphere. But let's look at it in an unprejudiced way: what is this quantity in comparison with the discharge of harmful substances from the stacks of local enterprises?

Any cellulose-paper combine annually poisons the atmosphere with hundreds, if not thousands of tons of all kinds of filth. Suppose you compare the air here, and, let's say, at Novodvinsk, saturated with 'wood processing giants.' We are far cleaner, isn't that so?"

Q: "But if suddenly there was a major accident during a launching, as was the case, shall we say, in 1985? After all, in such a case all the fuel is discharged into the environment. And that's a lot..."

A: "Here's what I have to say about the accident of 1985. At that time we carried out a group of measures for the neutralization of aggressive rocket fuel components. The snow and upper soil layer were transported away from the accident region and destroyed. There was an awful lot of tedious work involved, but we strove to reduce the losses inflicted on nature to a minimum.

...A small square in front of the cosmodrome headquarters was blocked with wet, heavy snow."

Q: "I'm interested as to whether the truth is being told about the ecology or not?" asked my colleague, the photographer, as if thinking out loud.

A: "You're from Novodvinsk, take a breath and compare. I dismissed the matter lightly, thinking what spin to put on it, but any human activity necessarily has an impact on the state of the environment. Does the country need paper? Well, in such a case for a long time we will have to put up with a not too pleasant closeness to cellulose and paper combines and cut down hundreds of hectares of forest. Are heat and electric power necessary? And tons of very valuable organic matter are daily transformed into smoke and soot... In each specific case one should not cry out 'Enough!' but soberly compare the effectiveness of the results with the degree of the inevitable losses inflicted on the environment.

"And from the unquestioning deference to scientific and technical workers we are now rushing to the other extremity. Away with them all! So now the selfless hard worker which cosmonautics has been, the pride of our country, whose necessity needs no proof, is cast in the role of an accused, a sort of 'scapegoat.' And the government, which gave birth to it and nourished it, similarly is now throwing fate to the wind; live as you can.

"However, today's careless attitude toward that which was accumulated and kept going during the preceding decades seems not to have affected cosmonautics alone, has it?

"Fine, fine," I answer myself internally to imagined opponents. "It is still necessary to figure out what return there is from the Plesetsk cosmodrome. It's not enough that they shoot millions of the people's rubles into the blue, they have to litter half the oblast with expended stages. What is the advantage to us who live in the oblast?"

What is the advantage? It was precisely this which I was to clarify in the course of a second meeting, called for later.

For the time being I and my colleague decided to stroll along the snow- covered streets of the mysterious, only recently secret city of Mirnyy, where people live who service and work at the cosmodrome.

There is a memorial set up at the "Orion" hotel; three symbolic rocket fins of white stone. Spruces, black against a background of white snow, stand severely and solemnly next to an eternal flame. This is a necropolis. Here lie buried soldier rocket specialists who perished at the time of two major catastrophes which occurred here during the launching of space vehicles.

Unfortunately, none of my fellow writers, visiting Mirnyy, ever have mentioned a word about these sorrowful pages in the history of the cosmodrome. But really, people must know and remember all those heroes, without exception, who gave to cosmonautics that which is most precious—their lives. Then, at least, some thought would be given to this: how moral are the present-day attempts to portray the people working in the space field, including officers, as nothing other than "idlers gobbling up government funds." Let those who think that way try to visualize a long motorcade of more than fifty trucks with coffins shrouded in red calico. That would make even hardened cynics think a little...

"Aleksandr Nikolayevich Stepanenko," said the official in charge, reaching out to shake hands. "Chief of the Northern Division of the Priroda State Center. Together with specialists of the Plesetsk cosmodrome we are making preparations for the launching of economic satellites of the 'Resurs-F' type, intended for remote sensing of the Earth's surface. This includes obtaining photoinformation, mapping and preparation of maps of those regions on which the State Center is working, with space information taken into account..."

Q: Thank you. But to be more precise: what advantage can our Arkhangelsk Oblast draw from cooperation with cosmodrome specialists?

A: "In autumn of last year oblast authorities and the deputy general director of our State Center, with participation of cosmodrome representatives, signed an agreement on multisided investigation of the natural resources of Arkhangelsk Oblast and Nenets Okrug.

"It must be noted that more than once we had proposed such cooperation to oblast authorities, but we were turned away. In the opinion of many, our involvement was feared primarily by representatives of the cellulose-paper combines. Already a very unattractive picture of their activity can be seen from space. Yes, and the timber industry. Indeed, all the overcutting of the forest, all the discharges of harmful substances, will be visible from space like in the palm of the hand...

"But a start has now been made. In this work there will be participation of dozens of scientific research institutes, including from Arkhangelsk. Projects in the fields of geology, transportation, pasture resources, and to be sure, vegetation and the ecology, will be worked on. Each constructed map will be accompanied by a 40-page explanatory note in which a prediction up to 1994 will be made. We will carry out the survey of Arkhangelsk Oblast free of charge.

"And, indeed, it's interesting how things go. We are working in Kalmykia, on the Arabian Peninsula and in Antarctica... And we are doing nothing for 'our' region."

Q: "Is it now possible to speak of any profit which the cosmodrome has brought in?"

A: "With respect to our 'Resurs' satellites, each year the State Center contributes to the budget more than 4 million dollars due to work with foreign clients. In our country alone 'Resurs' information is being used by 1250 organizations.

"You are impressed? Even if my interlocutors exaggerate a bit, even in this case the profit from the activity of the space department considerably exceeds the loss inflicted on the environment by the cosmodrome.

"And last, about the resources of the Plesetsk cosmodrome. In the immediate future, due to the planned reduction in the armed forces in the territory of Arkhangelsk Oblast (and not just here), thousands of reserve officers will appear. Including, obviously, from the cosmodrome. Engineers with the very highest qualifications, excellent organizers, disciplined and creative people at the height of their powers. However uncalled for this was—all this is due to the same 'carelessness' of our attitude toward the national good—these are highly valuable human resources, like until recently the oblast did not require advantages from the 'Resurs' satellites.

"But these are not machines, they are people..."

Private Firms Financing Satellite Launch

927Q0166 Moscow MOSKOVSKIY KOMSOMOLETS in Russian 21 Feb 92 p 1

[Unsigned item in "Priority News" column]

Sensational news! Private business, which on the one hand is plagued by excessive taxes, but on the other has the desire to aid a great space power, will be conquering space on a private basis. The commercial company "Hermes" [Germes], together with the firm "Elba", is financing the launch of an artificial Earth satellite. The project will cost seven million.

Plesetsk To Launch Privately Owned Satellites

LD2104095992 Moscow Radio Moscow World Service in English 0700 GMT 21 Apr 92

[Text] A Russian trade company, (?Khermez), has announced the launch of two satellites on 14 June from the Plesetsk Spacedrome in the north of Russia. These will be the first spacecraft belonging to a private firm. The satellites, designed by the Samara Research Center on the Volga, will collect data on the upper layers of the Earth's atmosphere. A spokesman for the (?Khermez) has said some Western organizations including from the United States have shown willingness to take part in those experiments.

'Rosobshchemash' President Advocates Recycling of ICBMs, Comments on Space Projects

927Q0131A Moscow TRUD in Russian 11 Apr 92 pp 1, 2

[Interview with O. N. Shishkin, president of the "Rosobshchemash" Corporation, by G. Vitalyev, place and time not stated: "Space Will Yield Space Profits"; the first paragraph is an introduction]

[Text] Today is the eve of one of the splendid holidays, 12 April, Cosmonautics Day. I think it will be marked modestly. Nevertheless, I would not want to belittle this day. The 31st anniversary of the flight of the world's first flight of a cosmonaut around the Earth is good reason for reflecting on the future of national cosmonautics, on ways for its survival in our difficult times. We will discuss this with O. N. Shishkin, former minister of the USSR Ministry of General Machine Building, now president of the "Rosobshchemash" Corporation.

[Vitalyev] Oleg Nikolayevich, in our your former ministry peaceful cosmonautics occupied a relatively small place; for the most part the objective was the production and servicing of land- and sea-based strategic missiles. Due to well-known decisions made on the reduction of strategic arms a considerable percentage of the missiles will be destroyed. Isn't that a shame? They were designed and built, hundreds of enterprises worked away, and now an explosion and that's it....

[Shishkin] I am deeply convinced that to blow up a missile is a disturbing act of squandering, a completely wasteful approach. Not to mention the fact that the production of a missile in the old prices cost more than a billion. But the very construction of each of them cost tens of millions. And now still more money must be spent on their destruction. However, with a reasonable approach it is possible to obtain here a considerable profit, not gigantic losses. What I refer to is the industrial use of high-quality rocket steel, rare metals and many electronic systems, in short, everything which may be useful in the economy. I therefore feel that the missiles should not be blown up, but instead cut up, with the metal being sent for remelting, and the wire and different parts to enterprises producing television sets, VCRs, etc.

The cutting up and remelting can be carried out under the supervision of American and other foreign specialists. It also is necessary to use the precious metal from missile silos (and there is a lot there). Then when an empty hole remains in the ground it can be blown up.

[Vitalyev] On what is solution of the problem dependent? [Shishkin] It is obviously necessary to discuss all this in the government, in parliament, and make agreements with the United States. I do not think that there will be any objections from the Americans.

[Vitalyev] When should the liquidation of strategic missiles begin?

[Shishkin] In the summer or autumn. There is time to reach an agreement, although not that much.

[Vitalyev] Will you also be able to sell the precious metal abroad? [Shishkin] To be sure, and we could live in clover for a long time. There are all the customers you might want. But the extensive sale of this unique metal would be to the detriment of national industry and I do not regard such a variant as acceptable. It is clearly possible to sell some part of the metal, but the most important thing of all is the interests of Russia.

[Vitalyev] And why do you not employ these rockets for the launchings of satellites, important for the economy, or under contracts with foreign companies?

[Shishkin] We also thought about this. To be sure, some of the rockets must be used for the launchings of commercial satellites. However, the need for such launchings is considerably less than the number of missiles to be destroyed. I refer to several thousands of strategic missiles. Accordingly, it is necessary to determine clearly: how many rockets will go to the cutting torch and how many will be used for the launching of satellites.

[Vitalyev] Will the enterprises of the corporation be engaged in servicing military strategic missiles?

[Shishkin] For the time being they will do so, there's no one else to do it. Highly trained specialists are required for this purpose. But I feel very strongly that a special state administration should be established for taking care of that, drawing the necessary specialists from us.

[Vitalyev] How many people are there now in the administrative ranks at "Rosobshchemash"?

[Shishkin] Ninety-five persons. But in its time there were 1700 people in the Ministry of General Machine Building.

[Vitalyev] What is the purpose of the corporation?

[Shishkin] Commercial activity. That is, drawing upon the free capital of our and foreign entrepreneurs and implementing commercial projects which will make it possible to use the great potential accumulated by the space branch. Here, in actuality, there is a concentration of the latest advances and high technologies. The loss of this potential would be a tragedy for the country.

[Vitalyev] Could you not tell about what commercial projects you refer to?

[Shishkin] For example, satellite systems for the development of television, communication and navigation. These three spheres are of the greatest interest among entrepreneurs. Even today many of them are ready to invest hundreds of millions of rubles and even billions in these projects. There is also more than a little interest on the part of foreign partners.

[Vitalyev] In other words, you are not seeking money but it is being offered to you....

[Shishkin] Yes, and a very strong competition is developing. It is understandable, this is advantageous. After all, we are not beginning from point zero, there are factories, technologies, surface facilities and well-developed scientific centers....

[Vitalyev] Have specific projects already been proposed?

[Shishkin] We are now examining several competitive national projects. I cannot reveal the details—these are a commercial secret. Discussions also are going on with foreign companies in the United States, Germany, India, China and South Korea. Incidentally, in the international arena the competition is still stiffer. Indeed, the annual profit which space projects yield is 4-5 billion dollars. I hope that we will be able to compete here successfully. Our systems, for example, are no poorer than INTELSAT and INMARSAT....

[Vitalyev] What is the fate of the 'Energiya' rocket? There was a project for using it for the launching of a superheavy platform with equipment for television, navigation and communication systems....

[Shishkin] Competition will decide everything. That project will win out which proves to be economically most rewarding.

[Vitalyev] It is said that the United States wanted to purchase the "Energiya" from us.

[Shishkin] These are only rumors. I have heard no such proposals.

[Vitalyev] You were recently in the United States. What did you hear about the fate of the proposal for a new Soviet-American manned flight?

[Shishkin] Such a possibility is being studied by the American side. For example, for a docking of the Space Shuttle with the Mir station. But for the time being it is too early to speak of specific decisions. In addition to all else, the Americans are very disturbed by the unstable situation in our country.

[Vitalyev] And will our "Buran" fly in the near future?

[Shishkin] For the time being this is not in the works....

[Vitalyev] And last. Do you feel that cosmonautics will survive under the prevailing difficult conditions?

[Shishkin] Unquestionably. Initially it will be afforded definite assistance by the state. But later practical cosmonautics will be developed on a commercial basis and it will be possible to carry out fundamental research on the basis of appropriations from the budget. The Russian Space Agency, which has just been established, has much work to do.

Cosmonautics is at the forefront of our industry. Without doubt it will prove to yield enormous advantage to the country.

Institute Proceeds With 'Start' Space Launcher Project

LD2503095392 Moscow Teleradiokompaniya Ostankino Television First Program Network in Russian 1800 GMT 23 Mar 92

[From the "Novosti" newscast]

[Text] Conversion is the Latin word for transforming or changing. The state has scarcely allocated any money for this transformation in 1992. But cuts in military orders by a million rubles require conversion investments of around 1.2 million rubles. What is the way out? One of the most famous design bureau, both here and abroad, has chosen its way of resolving this problem.

[Unidentified correspondent] This is the Moscow Thermotechnics Institute. No journalist has set foot here before, let alone a film crew. We are the first. This is where they used to build the missile complexes SS-20 and SS-25. On the basis of this technology development is currently under way of a space rocket complex with the Start rocket, which is essential for launching small earth satellites. These serve various purposes—satellite communications, prospecting natural resources, ecological monitoring, and so on.

How does the Start project combine with the disarmament treaty?

[Solomonov] The project fully accords with the international agreements which existed previously and which exist to this day. It can be said that all the military elements have been taken out of the rocket complex and out of the rocket.

[Correspondent] What is the source of finance for your project?

[Solomonov] We have managed to find domestic businessmen who are acting as sponsors. To date we have both the money and everything we need to carry out the project. We would like to have the support of the appropriate state structures. It is not money I have in mind, but contractual and legal support.

[Announcer] The launch of the space carrier-rocket Start is planned from the Plesetsk cosmodrome at the end of this year. Design bureau live from their sponsors, the state complains at the absence of funds which it can direct to these sectors, but conversion can provide mountains of convertible currency—yet another paradox of our times.

Chief Designer of NPO Energiya Branch Gives Views on Space Program

927Q0113A Moscow MEGAPOLIS EXPRESS in Russian No 12, 18 Mar 92 p 12

[Interview with Stanislav Petrenko, chief designer of Volga Branch, Energiya Scientific Production Association, by Mikhail Arkhipov: "There are Attitudes Toward Space. As Distinct From Money. Time to Remove the Cornerstones From the National Space Program"; the first two paragraphs are an introduction]

[Text] The darling of Soviet cosmonautics, the Buran shuttle, was launched into orbit only twice. But it has been subjected to criticism an incalculable number of times. Because enormous sums were invested in its development and because it was constructed by order of the military. Because it supposedly was copied from the American Shuttle and because in the last analysis no one needed it.

In addition to the Buran, the system developed for putting it into orbit, the unique Energiya booster, has fallen into disrepute. Although Stanislav Petrenko, chief designer of the Volga Branch of the Energiya Scientific Production Association, feels that precisely it should become one of the priority directions in development of national cosmonautics at the present time, which is so difficult for us.

"The criticism usually emanates from a comparison of our ship with the American system. But the Space Shuttle system is intended for putting only one type of spacecraft into orbit. Whereas our system is considerably more flexible. All of its components can be used—both together and separately—for putting vehicles of different types into space. This in essence is an entire class of ecologically clean modern boosters making it possible to put loads weighing up to 100 tons into reference orbits. And with its propulsion modules the Energiya also will be able to carry from 18 to 22 tons of payload into geostationary orbits. The Shuttle cannot do this. The Energiya is the world's only superheavy booster capable of solving such problems. Incidentally, it could even now bring in a profit. In a single launching it can put into space entire orbital stations—factories for the production of unique pharmaceuticals, growing crystals and developing new technologies."

Q: "You will agree that it is quite difficult to dream about orbital factories when many fully 'terrestrial' plants in the country are coming to a standstill. Possibly the Energiya will promise us something more real?"

A: "The heat insulation used on the Energiya (it withstands drops from +250° to -250° for a period 25-50

years) can be used fully in construction. Buildings covered with a 2-cm layer of such insulation will not require steam heating. Or any heating at all! Incidentally, cooperative workers at Samara have already 'grabbed hold' of this insulation. They are using it for repairing the roofs of administrative buildings and dwellings."

Q: "It probably costs plenty?"

A: "If the cooperatives use it, it means that it is within reach. However, the insulation is only a single example. A mass of special fittings was developed for the Energiya for functioning under any weather conditions and in a very wide temperature range. All this is extremely necessary for both firemen and metallurgists and volcanologists and drillers. And, let's say, our fuel delivery system, if used in the oil and gas distillation branch, could guarantee the prevention of catastrophes such as that which occurred at Ufa.

Q: "Cosmonautics today is under the constant gun of critics. Do you personally feel it to be responsible for all our misfortunes?"

A: "To be sure, space programs must now be reexamined. Indeed, the cornerstone for them previously was the competition between the East and West—economic, scientific, political, military. Now this 'stone' must be taken away.

"Incidentally, if the purely military-technical aspect of the problem is considered, then space technology, the same Energiya booster, cannot be a means for attacking anyone from space. It is too large and convenient a target for an enemy. In particular, since during prelaunch operations it spends more than two days on an unprotected launch pad. True, it can be employed in putting loads of the most different purpose into orbit: including military satellites. I might add that the conversion carried out among rocket builders in no way can be equated to the conversion of plants producing tanks, howitzers or Kalashnikov automatic weapons. Our conversion involves the organization of programs for the peaceful exploration of space. Although, as long as there is a state, armed forces should be one of its normal attributes, and for them surveillance should be a normal function. There's no way to get around it. Well, our boosters and the corresponding satellites will make it possible to solve problems which also include these. In the present-day political situation they must become tools for monitoring, primarily of what is going on in the country."

Q: "In speaking about the state, you have in mind the Commonwealth or at least Russia, the rightful successor of the former USSR?"

A: "Despite the agreements signed in Minsk, not one of the participants has yet allocated a cent to cosmonautics. Accordingly, everything which we are now building is coming from the Russian budget. But the economic situation of Russia itself is extremely unstable. This, incidentally, also is driving away from us Western businessmen who would like to invest money in our space industry. But they do not at this time have any juridical guarantees. Although the West, all the same, has great commercial interests in our cosmonautics. After all, our systems for putting loads into space are the most reliable and least expensive.

"The cooperation scheme could be simple. Entering into agreement with us, the businessmen, using their money, by means of our booster could put into orbit a space station which could link together the entire world by space communication. And by developing with us the documentation for the production of telephones with whip antennas and taking a license for their sale, the company would never be in the red! Then we could evaluate what cosmonautics can really be if, for example, our farmers, digging up their gardens, could calmly converse with their colleagues in Canada or Australia. Our main enterprise, the Energiya Scientific Production Association, has already developed a universal space platform (an ultrapowerful center for an orbital telephone station) which is capable of ensuring global communication not only for Russia, but also for the entire world. But who is there to take on the financing of this work?"

Q: "Possibly assistance can be expected from national businessmen?"

A: For the time being, in accordance with a decree of the Council of Ministers of the Russian Federation, enterprises for the development of space vehicles are not subject to privatization. Although commercial interests in actuality are approaching us with that kind of proposal."

Q: "What are the prospects for cosmonautics?"

A: "I am a realist. I assume that neither this year nor next will sufficient sums be allocated for continuing existing space projects. I see the principal objective of space design bureaus and space industry in general to be the retention of personnel. The best people, the professionals, are leaving. This phenomenon is assuming a catastrophic character. This can push Russia many years backward, to the initial point of development."

Prospects for Samara's 'Progress' Space Equipment Plant

PM0204140192 Moscow ROSSIYSKAYA GAZETA in Russian 28 Mar 92 First Edition p 3

[Interview with Anatoliy Petrushin, deputy director of the "Progress" Plant in charge of economic issues, by Mikhail Arkhipov, under the "Conversion" rubric; place, date not given: "Rocket-Propelled Sofas" —first paragraph is introduction]

[Text] The situation in the military-industrial complex is close to catastrophe. Missile construction—one of the two sectors which sustained the might of the Soviet state—is nearing collapse. For more than half a century the "Progress" Plant has been regarded as one of

Samara's most prestigious enterprises. Its workers make the R-7 rocket launchers, which launch all manned Soyuz craft, as well as other space equipment. Today highly skilled specialists are quitting. What does the future hold for the plant? Anatoly Petrushin, deputy director in charge of economic issues, takes the floor.

[Petrushin] Conversion has not been well conceived. The production of space equipment has been declining year by year, but is not ceasing altogether. They will not let us switch to civilian production completely, but they do demand that we produce civilian goods—in the same work areas and using the same actual equipment. Our consumer goods are proving to be money-spinners.

Previous conversion credits weigh heavily upon the plant. There has been no government decision to date to write them off, and we continue to pay high rates of interest to the bank.

The volume of production for the year is not clear. Nor is the volume of orders for the ultrapowerful Energiya launch vehicle. What kind of research and development work will we carry out? Nor do we know what kind of work will be taken on by our specialized shops, not just in Samara but also at the Baykonur space center, where we have large production capacities.

All this naturally has an effect upon people. To prevent our losing people, we are forced to take on work which is remote from our basic specialized activity. For example, we have set up a shop producing disposable syringes. And although only around 300 people work there, one-half of the profit earned by the plant last year cane from syringe production. Could the situation be more absurd?!

[Arkhipov] Anatoliy Ivanovich, as far as I am aware, "Progress" is due to start producing streetcars soon. You will hold on to ordinary people, but you will eventually lose the specialists.

[Petrushin] It has become clear that the country's demand for streetcars is already being met by another plant. It seems that instead we will be producing cars for electric trains. The military-industrial complex is undertaking to finance the order.

[Arkhipov] What do you think about the possibility of "Progress" being privatized? Could that be the new boost to the development of the space industry?

[Petrushin] Many opinions have been expressed on this score in the shops, departments, and services of the plant. It is unrealistic, I think. It is my profound conviction that cosmonautics should remain under the control of the state—as is customary in all aerospace states. Cosmonautics means above all scientific potential and advanced technology, in short, everything that enables the level of a state's development to be judged. And the state should bear responsibility for its space activity.

"Progress" has a host of subcontractors, some of which have turned into cooperatives and small enterprises. It is now simply dangerous to work with them: They demand a twenty-fold increase in payment for components, otherwise they threaten to close production down. We have approached the government, but it merely points out the contract prices to us. What is the upshot? Until last year the R-7 rocket was the cheapest launcher in the world. Today its price has increased several times over. And five to six times fewer launchers and satellites have gone up. What kind of privatizer will be able to survive with such prices? Privatization will lead to just one thing: The replacement of space production by something that is short-term and ultraprofitable. The sophisticated equipment will then go out of commission and the plant will go under the hammer...

[Arkhipov] Will "Progress" be able to undertake the production of certain space systems if Ukraine curtails its space activity? For example, the Zenit-2 launcher made by the "Yuzhmashzavod" Plant in Dnepropetrovsk?

[Petrushin] We know the Zenit-2 well, after all, we are already producing the Energiya, which uses the Dnepropetrovsk plant's Zenit as a first-stage strap-on booster. The production of a modern, environmentally clean rocket would be completely in keeping with our interests.

As far as other equipment is concerned, a prototype of a new Energiya-M launcher capable of carrying loads of up to 40 tonnes into staging orbits already exists in mock-up. It is undergoing tests. The Proton-class launcher has become obsolete and does not meet environmental requirements. The Energiya-M is a promising piece of equipment. It is a pity only that the financing of our research efforts has now been suspended.

Cosmonaut Training Center Exploring Ways of Earning Money

927Q0104 Moscow DELOVOY MIR in Russian
7 Mar 92 p 11

[Article by Svetlana Omelchenko, DELOVOY MIR reviewer and cosmonaut-researcher N 151 (from Zvezdnyy Gorodok [Star City]), under the rubric "Earth and Space": "Invitation to Weightlessness, or How the Cosmonaut Training Center Is Surviving in Market Conditions"; first four paragraphs in boldface are source introduction]

[Text] **"The Flight Control Center has gone to the crew and asked them to advertise for AvtoVAZ," the assistant to the chief of staff of the Cosmonaut Training Center reported to his boss. "Aleksandr Volkov requests permission."**

"On what conditions?" Ye. Dyatlov asks. "Why didn't they specify them?"

"Advertising like that should be mutually beneficial," he said, turning to me. "Cosmonaut Volkov will receive 60,000 rubles (R) for the flight, but the Oka automobile costs 80,000."

That brief episode preceded our conversation about how the Cosmonaut Training Center, a state-budget-funded organization, intends to survive in market conditions.

"Money has to be earned," Yevgeniy Grigoryevich [Dyatlov] muses aloud. "Which is something that we've already been doing for a long time now, in training foreign specialists how to execute commercial space programs. But we haven't gotten a single copeck for it yet. All the hard currency has gone to the state's and the NPO Energiya's "coffers." According to the contracts, the money wasn't for training—it was for the flight as a whole and for the support of it. We estimate that the cost of training a cosmonaut accounts for roughly 12-15 percent of the total cost of a project, depending on the complexity of the program.

"In May of last year," Dyatlov continued, "we finally got permission to conduct independent foreign business activity, and we even set up what for now is a small department, but which we hope will grow into a subdivision.

"Now we're officially allowed to provide other governments services involving the training of cosmonauts and the testing of equipment and advanced technologies and to participate in joint scientific research and joint development of new technologies.

"I feel that all organizations that have anything to do with commercial flights should sign a separate agreement that specifies, in a percentage, what their efforts in the execution of space projects amount to. That pertains to the Institute of Biomedical Problems, which screens [cosmonaut] candidates; to the NPO Energiya, to which the rocket-space equipment belongs; to the Flight Control Center; to the launch complexes; to the search-and-rescue services; and to the array of other organizations that support the science experiments, the communication sessions, etc.

"That same kind of policy should be introduced in the execution of intrastate space programs."

"And should the methods specialist, who teaches the cosmonaut how to, for example, perform some sort of experiment so as to ensure its integrity, and the trainer, who is responsible for the physical training of the crew—should they also know what their labor costs?"

"Absolutely. But for the time being, even the cosmonauts don't know what their work will be valued at after the flight."

"At the end of last year, our group of journalists and physicians, after finishing our general space training, encountered rather frequently in our training sessions—in the gym, in the water tank, in the simulator complex—three French specialists—a pilot, a scientist, and a woman doctor. But they hadn't been at the Cosmonaut Training Center for very long, just a couple of weeks, and in that span of time they had undergone training in weightlessness on the flying laboratory and underwater in diving gear, they had gone up in the altitude chamber, and they had become familiar with g-loads on the centrifuge. Can cosmonauts really be trained in such a short period of time?"

"You were witnessing yet another of our commercial experiments. Yes, those were French cosmonauts. They were becoming familiar with selective techniques and were going through a training period. They recently sent back positive testimonials. If the need arises at some later date to train them to perform some specific program, they will be able to make it through the entire course.

"Almost the entire French cosmonaut corps has been trained by our Center."

"I've heard that the Americans charge much more money for such services, and right now that's the only reason other countries are turning to us. But the need to live on our own money may force us to raise our prices, too, and won't that turn away our future foreign partners? With prices equally high, they'll prefer quality."

"Patrick Baudry, the backup for Jean-Loup Chretien, went through training here and in the United States," Dyatlov said. "And he spoke highly of the quality of our work more than once. Nowhere else in the world, not even in the United States, is there equipment that can match ours in making the training conditions so close to real space conditions; nowhere else is there such a technical base."

"And I'll continue the list: nowhere else are there such selfless instructors, who, out of enthusiasm alone, almost for no pay, are willing to pass their know-how and mastery on to cosmonaut candidates, instructors who are capable of inculcating, even into our especially nontechnical heads, the necessary technical information about the systems of the spacecraft and the station. V. Gorbunov, A. Pavlov, O. Polovnikov—those are the real talents, the gold reserves of the space program!"

"Yes, the Americans pay more heed to self-training, and all the tutoring is for a fee.

"Our techniques of screening, teaching, and training are of immense interest to our foreign partners."

"But aren't we showing our cards too much in our open-hearted generosity? There are staunch rumors that the French intend to open their own cosmonaut training center."

"In fact, that issue has been discussed. But as early as last summer, during the visit of our delegation to France, where the crews for the performance of the joint flight program were announced and the French had an opportunity to become familiar with the details of the program, there was an official announcement at a press conference that it would be unwise to open, in Europe, yet another cosmonaut training center. Our Cosmonaut

Training Center, in the opinion of our European partners, is capable of handling all the problems associated with the training of specialists from all the countries of Europe for space flight."

"Moving to the European level will require additional spending on, for example, spacecraft simulators."

"The Buran simulators can be fully adapted for the French Hermes. We've already done test training sessions, and the results weren't bad at all.

"But there'll be spending, of course. We need to buy equipment—electronics, computers, microcomputers. For a number of years, when we were outfitting our spacecraft, our stations, and our modules, we geared them to domestic equipment exclusively. After all, from time to time, something goes out of service and needs to be replaced. We felt that the problem of spare parts and the replacement of assemblies would be easier to handle here at home. But the Western electronics industry passed us long ago, and it doesn't make sense to be standing still with our own instrumentation. We need to use all the best that the world industry can offer."

"In other words, you don't have any problem figuring out how to spent hard currency. But what other ways of earning it do you see?"

"Our technical base, I reiterate, is unique. It can be used for testing that same electronic equipment and other equipment designed for space research in weightlessness and under heavy g-loads; it can be used for testing samples—materials, preparations, equipment.

"In the summer, in Germany, we intend to hold a conference in which we will tell about all our capabilities. The specialists and scientists can have a look, see for themselves, draw their own conclusions.

"We are planning our participation in foreign air shows for the purpose of advertising.

"One steady source of income could be from foreign and domestic tourism. Every year, Zvezdnyy Gorodok is visited by nearly 150,000 tourists, some of them foreigners. Until now, we were a little embarrassed to take money, especially from our fellow countrymen, and we felt that an educational mission should be free of mercantile interests. And maybe that's the way it should be.

"But for wealthy foreign tourists and businessmen who are attracted to keen sensations, we could suggest that, for an appropriate fee, they experience the incomparable sensations of weightlessness on the Il-76 flying laboratory or that they feel what g-loads are like by spinning on the centrifuge; we could give them the opportunity to experience all the "charms" of being in the no-frame-of-reference water tank in a real space suit. And after the complex of training sessions, which, of course, would be conducted under the supervision of our physicians, certificates could be given to the hardiest of the tourists. I think a lot of people would pay dearly for such a souvenir and for the opportunity to experience "out-of-this-world" sensations, don't you agree?

"By the way, our first attempts at exposing foreign tourists to space training sessions have already taken place. They were in ecstasy, I'm telling you!

"There are a lot of ideas floating around. What do you think of the idea of opening here an international pilot-training school? Or a school for survival training for extreme climatic conditions, with the students going out into the polar tundra or into the desert? How are our specialists any worse than the famous Yatsek Polkevich from Italy?

Worth some attention, too, is the suggestion of Cosmonaut A. Serebrov that we open an international space camp for children at the Cosmonaut Training Center, to familiarize them with simulators and to attract them to scientific work."

"But what will the people, the specialists who work in Zvezdnyy Gorodok, get out of all this commercial activity?

"Every year, several dozen people are let go, and that number is expected to be even larger now. They're highly skilled specialists who are devoted to the space program and are well versed in its history and traditions. They always have problems getting other jobs. Nowadays, they often find work far from home, and have to spend a good deal of time on the road, not to mention that their potential isn't fully used for their benefit and the benefit of others.

"They would have the opportunity to be involved in their favorite activity, and to earn money, too."

Glavkosmos Chairman Dunayev on Space Sector's Need for Funds

927Q0120 Moscow KURANTY in Russian
No 45, 6 Mar 92 p 5

[Interview with Aleksandr Ivanovich Dunayev, by Zhanna Shanurova: "Space Is Again Asking for Money"; first two paragraphs are source introduction]

[Text] **It turns out that we were all under the fist of the space KGB. The domestic satellite system Gonets alertly kept an eye on ours and theirs. More than 70 percent of the funds released for the space program were lost on military aims, providing no one any daily bread. It's not surprising that nowadays, hearing the word "space" brings out the aggressive side in many citizens. And yet, once again, space is asking for money.**

Although the representatives of space organizations are now promising everything under the sun not to the military-industrial complex, but to the national economy, no one is rushing to cough up any money. Why not? Can't the space program give anything to business? Our KURANTY correspondent had a conversation about that with the chairman of Glavkosmos, A. Dunayev.

KURANTY: Aleksandr Ivanovich, until very recently, the space program was cherished and pampered. But now it has become the scapegoat for the economic gaps being felt by our country. What, in your opinion, is the cause of such a striking change, and will the space program soon be pushing up daisies?

DUNAYEV: The Americans do this: without having even one operating space station right now, they parade masses of people through mockups, and they read them lectures there about how much stations, satellites, and rockets of various sizes cost and what their purposes are. In that fashion, the American, from childhood, is raised to respect space. Our tragedy is that we still haven't shaped any strong public opinion about why we need space. Of course, it came out of closed defense enterprises, where everything was kept secret, and our society saw only the gala dispatches about it. Here now the curtain has been pulled away a little, but for naught: people aren't ready to associate space with beneficial things or with economic problems. It always seems to them that it is eating them out of house and home.

Yes, in 1989, space did "eat up" nearly 7 billion rubles [R], and then 6.3 billion, and last year, still less. But if you consider that in that field the volume of unfinished production alone came to more than R180 billion, then the allotted funds are just bread crumbs, a laughable sum. The space program is badly in need of money, but there isn't any.

At one time, there was the concept of nominal economic impact. A photograph from space, let's say, would yield 7 rubles profit on every ruble spent. But where are those rubles? We've transferred 600 achievements to the various sectors of the national economy, but what happens? They tell us about the nominal economic impact instead of saying here's a million for you. But that kind of thing is possible only in a market economy.

People rail at us and criticize us. They say, You're bad businessmen, and you fleeced the Japanese for some $14 million. But look, the Americans asked $55 million for the training of three Japanese cosmonauts and for two tones of gear. We, on the other hand, took 16 million for two Japanese and 100 kilograms of gear. And the manned flights have brought some $50 million in to the country. The spending on the station, however, is as much as a million a day. You add it up. Can we, using those commercial flights, keep the station going without any additional financing?

KURANTY: But where are you going for the money?

DUNAYEV: Wherever we have to. We've begun to sell hard currency at auction. We're arranging space exhibits abroad. We've started helping India to launch satellites and develop experimental design operations. Brazil is next. And the European Space Agency would like to make use of our potential. It's just the domestic investors who don't need anything. They want to grab everything in the near, foreseeable future, and they can't bear to wait for a return five-10 years down the line.

KURANTY: But as far as I can tell, you yourselves are the entrepreneurs. You even have two small enterprises. By the way, what do they do?

DUNAYEV: Several years ago, when we began setting up the small enterprises, the board nearly took our heads off for it. Our small enterprises, by the way, are involved in introducing conversion at Moscow plants. For example, one defense enterprise has begun using space technology to manufacture beer vats made of stainless steel. And all kinds of souvenirs.

KURANTY: But why don't you open an exchange and trade in your products? I'm thinking of space-derived information.

DUNAYEV: We are doing such things. We have closed exchanges, and brokers' offices. We're taking part in all sorts of funds. Don't worry, we understand a little about such things—we're just not advertising it.

KURANTY: Which means, you're again keeping everything secret?

DUNAYEV: Why not? We're not going to open up that part of our operations. The public doesn't need to know that at all. It just needs to know who will go aloft, what will go aloft, and for what purpose. Why should the individual invest his ruble in space?

KURANTY: Does that mean that you don't need any assistance?

DUNAYEV: No, we do need it. Of course, we're trying to earn money ourselves, but we're not earning the amount we need. We're not talking millions, but billions. We've put together a Space Program of Russia, but until Yeltsin approves it, I'm not saying anything about it.

KURANTY: Maybe you could enlist the help of businessmen? What would you suggest to them? Where specifically can they invest money in a way that would have a space slant?

DUNAYEV: Well, anywhere. For example, we don't have our own ecology system. The Okean satellites are aloft, but none that can perform every type of ecology-related job. If some businessman were to invest funds into an ecology-related system, I'd put his name down in history in gold letters. We're talking about some big spending, though. A satellite costs several dozen million rubles, and the most complex of ground equipment is needed for it. But, as a rule, we have never had the money for the ground: we've done one part—the space part—but we've forgotten about the other. Look, let's say there are seven or eight Gorizont satellites floating around up there. Beneath them they put up a thousand communication stations, when what we need is 10,000. That's how we'll call to each other not just in communications.

KURANTY: Why hasn't that all been resolved before?

DUNAYEV: First of all, it's defense matters that have been taken up. Some 70-80 percent of launches have been military launches. And Buran is a military system, and it was only later that it was pushed aside to the civilian sector. And on the Mir station, the military took its percentage. So what was left for the civilian sector—one, two, three percent? And you still ask why that was so. The national economy was in the background.

KURANTY: What other down-to-earth things can you suggest to entrepreneurs?

DUNAYEV: Put together a system for Moscow, a land cadastre—i.e., provide a complete, objective description of the land. When plots of land are privatized or when they're sold at auction, a cadastre would of decided importance. But that wouldn't take photographs—we have more than enough photographs already. It would necessitate a great many calculations performed on the ground, not in space. Similarly for agriculture. A photograph doesn't help the farmer any—he needs a subject-oriented analysis of the land.

That's where businessmen could invest their money.

Russian Working Group's Analysis of Needed Space Program Reforms

927Q0133 Moscow PRAVITELSTVENNYY VESTNIK in Russian No 7, Feb 92 p 5

[Article consists of text written by Russian Council of Ministers Space Program Working Group with regard to management of space activity in Russia, under the rubric "The Scientific-Technical Revolution and the Economy": "Russia and Space"; first nine paragraphs, italicized, consist of boxed text signed by S. Zhukov, I. Moiseyev, and V. Postyshev; source introduction, in boldface, follows]

[Text] *Russia and space. Those words are inseparably linked in history. Kibalchich, Tsiolkovskiy, Korolev. The first satellite. The first cosmonaut. Russian and space. Today, it depends on us whether that linkage will remain merely a part of the past or not.*

It would be a shame if, because of the problems of survival, we forgot about the things we should not lose. And that includes the space program, which, today, is not numbered among top-priority matters.

One day without the space program would be a sobering experience for a lot of people. Just imagine if all the satellites circling in orbit were switched off. The country would experience an acute information shortage. Some 90 percent of the population of Russia would not see TV Channel 2, and tens of millions of people would be without television altogether and would not get their daily newspapers on time. It would take weeks to get through by telephone to cities like Vladivostok and Murmansk, because you can count on one hand the number of cable lines connecting those regions with the center.

Without satellite information, the not-always-reliable weather forecasts would be worse, and the capabilities for timely evaluation of harvest would vanish, as would those for timely evaluation of the state of the environment or the aftermaths of natural disasters and military conflicts. The crews of ships and aircraft in distress would have to wait longer for help, and routine navigation instruments would be silenced.

Today we can't get along without space, and tomorrow space will be 10 times more necessary. Paraphrasing a well-known thought, one could say that the country that wants to have an independent future must have an involvement in space.

The Russian leadership has long understood the exceptional importance of preserving for the republic the status of a space power. On 18 September 1991, the deputy chairman of the Russian Council of Ministers, M. Maley, formed the Space Program Working Group for developing proposals for organizing the management of space activity in Russia.

The group, which consisted of specialists of the space sector and independent writers, gathered the suggestions of the leading industrial enterprises and scientific institutions and analyzed them. Drafts of documents involving the creation of a Russian Space Agency, plus specific suggestions for reform in the space program, were sent to the government in November. The papers produced by the Working Group were examined and approved in toto in the ministries of the Russian Federation. That's when the report "Space Policy of Russia" was completed. The report was sent to the Supreme Soviet and then sent by government leaders to the president. On 30 December, in Minsk, the Agreement on the Joint Activity of the Commonwealth States in the Study and Use of Space was signed. The text of that agreement was created with the active participation of the experts of the Working Group.

Space reform, however, has dallied on the launch pad. New working groups and commissions are being created. Instead of action, we have polemics in offices. What is the essence of those polemics? Without getting into the details, it is this: there's a conflict between efforts to resurrect the old management structures under new signs and the suggestion that we form a new system for managing space activity, one that takes into account the changes in the country and in the space program itself.

We, however, feel that we must not let the space program die and that we should quickly create a Russian Space Agency. Problems involving the financing of a State Space Program of the Russian Federation need to be solved. Common sense should reign here over emotions. Of course, we should abandon financing ineffective programs, thereby ensuring the survival of promising areas and preserving our space potential. And another thing: the discussion of the problems associated with space reform should be out in the open. The games of secrecy have already cost the space program dearly, and at this point they could ruin it. That is why we suggest that the readers

of the PRAVITELSTVENNYY VESTNIK become familiar with the materials prepared by the experts of the Space Program Working Group.

Cosmonautics, which changed the face of civilization, came about in Russia. The work of Russian scientists, engineers, and workers laid the foundation for the study and development of space.

The country's space complex today encompasses more than 1,000 science and production organizations. The space program accounts for as much as 1 percent of the country's gross national product. More than 1 million people are directly connected with the space program. Over the span of four decades, at a cost involving considerable expense, the USSR created in that field the world's largest scientific-industrial infrastructure. Space-related programs are supported by two launch facilities from which, every year, as many as 100 launch vehicles carrying several hundred tons of payload into space lift off. (In 1990, there were 76 booster launches; in 1991, there were 60.) In operation are more than 30 satellite systems, which handle tasks involving defense, the economy, and science.

If things are set up in an economically correct manner, space science and industry are capable of producing a tangible effect and, within five-seven years, repaying the money invested in them. For example, space-based communications are five-six times cheaper than the usual, cable-based communications. Space-based observations of the state of the environment can produce a return of 7 rubles [R] for every ruble spent. In a country the size of Russia, satellite systems are the only acceptable means of setting up communications and television and radio and of providing timely information to the weather, ecology, geodesy, and cartography services. A substantial return is expected from the in-orbit production of biological preparations, semiconductors, and other unique materials.

Space technologies provide fundamental breakthroughs in economic and social problems and a manifold savings of resources. The fact that more than 120 countries of the world are, to varying degrees, taking part in the development of space speaks for itself. The USSR, the United States, France, Japan, China, India, and Israel possess independent capabilities to manufacture and launch spacecraft. Brazil, Iraq, Pakistan, and Argentina are close to having such capabilities. Canada, Indonesia, Mexico, and the countries of the European Space Agency and the Arab Organization of Satellite Communications have their own satellite systems. The international space market is developing rapidly. Its annual volume exceeds $15 billion and, by various estimates, will be $100-200 billion by the year 2000.

Our space program is one of the few sectors in the country that has achieved a world-class level. Today, however, it is on the verge of collapse, especially in financial and economic terms. In 1991, space-program financing was 35 percent below the 1988 level. (At the same time, space-program financing grew in the United States by 11 percent, in Japan by 14 percent, in FRG by 41 percent, and in France by 6 percent.) In addition, nearly R700 million was removed from the earmarked volume, which left fourth-quarter operations in 1991 with no financing. The charges associated with signed agreements and operations already performed have been frozen. At any given moment, some 50 percent of production capacities are idle. Social problems have become acute. The average wage is only R290 (based on data for September 1991). Space science and industry have lost 25-30 percent of their extremely highly skilled staffers.

What is extremely dangerous is the uncoordinated manner in which Union property that affects facilities of the space infrastructure is being divided up. Such things could paralyze the work of space systems and the execution of space-related programs. The consequences would primarily affect Russia, because as many as 80 percent of the enterprises and organizations of the space complex are located inside Russia's borders.

Predictions indicate that if there are three or four more months of inactivity, the space potential of the country will be irrevocably lost.

There is only one way out—to quickly and vigorously reform the space program so that it comes in line with the principles of democratic state management and a market economy and with the legal bases of the life of the society.

Space Policy Priorities

As paradoxical as it may seem, a crisis is a powerful stimulus for forced development. During a crisis, political principles change, as do the social forces behind them. The possibility for reform arises. The success of those reforms hinges largely on the level of interest displayed by broad strata of the society, and that interest, in turn, depends on how well informed the society is. Today, as never before, we need an open space policy. Reform of the space program must begin with a definition of the goals and objectives of space activity. Those goals and objectives must be based on the capabilities of space science and technology, on economics, on needs, and on the specific features of the state. Clearly formulated goals and objectives determine the criteria for the selection of space projects and must be recorded legislatively as the priorities of the space policy.

For Russia, the goal of space activity can be defined as the following:

the use of space potential for realizing economic, defense, technical, science-related, social, cultural, and international interests of the Russian Federation.

Based on that goal, we need to do the following:

employ space equipment for the development of communications; radio and television broadcasting; weather,

navigation, geodesy, and cartography services; sensible use of resources; ecological monitoring; and in-orbit production of unique materials;

use space systems for performing basic research in earth sciences, astrophysics, planetology, and biology;

study space-medicine problems, including those that could improve health care;

employ the achievements of the space program to accelerate scientific-technical progress; transfer space technologies to the economy;

use space-program resources to raise the educational and cultural levels of the population;

use space systems to warn of natural disasters and emergency situations and to support cleanup measures after such situations;

improve the effectiveness of the defense of the state by using armed forces space systems;

verify adherence to international treaties involving arms limitations and disarmament;

use the achievements of the space program to promote the foreign economic and foreign policy interests of Russia.

Management of Space Activity

The current crisis in the space program is a typical management crisis. Our country has more than enough material and intellectual resources for performing research and experimental-design work, including work involving the development of space. The whole problem lies in how to organize and how to use our productive forces.

The system for managing our space program did not develop on a sound basis and was merely a copy of the political structure of the society. At first, it was a complete pyramid that unfailingly performed the tasks assigned it. The politicians who were charged with the responsibility for the state of the environment depended directly on the intellectual leaders. The intellectual leaders were strictly guided in their own activity by the specific goals they were given. The system had a serious flaw: there was no comparison of results and the means for achieving them. Surface indicators—the launch of a new booster or manned spacecraft, for example, or the performance of an EVA—were often considered the only criteria of success. That was one of the reasons for our increasing technological lag despite the outward similarities of our space projects and those of foreign countries. Nevertheless, under the conditions that existed, the system for managing the space program was, on the whole, fairly effective.

Upon receiving a great deal of freedom, the ministries and the large design and industrial units traded state interests for departmental interests. The prospects of the development of the space program were beginning to be determined not by the consumer, but by the producer. Conflicts sprang up between scientific*production monopolies, and there was a struggle for influence with the center. The upper level of management, under constant pressure from below and receiving contradictory information, continued to lose control of the situation. Complex projects couldn't be critically evaluated. The chief criterion for their selection was the presence of similar projects in the United States, plus other attendant circumstances. Internal stimuli for the progress of space science and technology were undermined. Instead of a search for breakthrough solutions, technical approaches that were becoming obsolete became fixed in place.

The space-program administration in existence by August 1991 was based on a management chain that went like this: the CPSU Central Committee Secretariat—the USSR Council of Ministers State Commission for the Military-Industrial Complex—ministries and agencies (primarily the Ministry of General Machine Building, the Ministry of Defense, and the USSR Academy of Sciences)—the enterprises and organizations. The management circuit included nine ministries of defense sectors of industry, a number of other agencies, dozens of government organs and institutions, and hundreds of industrial enterprises and science organizations.

Unlike in the initial period of development of the space program, this pyramid was eroded. In recent years, the apparatus of the CPSU Central Committee and the military-industrial complex provided only formal approval of projects submitted to them. In essence, the center kept for itself functions of ideological control, the chief function among them (in bureaucratic logic) being the authority to name and remove officials. The key function of goal-setting was distorted. In the absence of independent analysis and public access to information, decisions regarding space projects were affected by outside factors, including even the personal relationships among the leadership. The absence of an efficient system for choosing goals was the main reason for unsound decisions, which resulted in losses estimated to be in the tens of billions of rubles. (The Buran program, for example, accounted for losses of R20 billion, and the manned Moon mission program, R3-4 billion; a number of military programs lost money.)

The mixing of management functions and the transfer to agencies of control of objectives not essential to them were terrible mistakes. For example, many times the USSR Ministry of General Machine Building and the USSR Ministry of Defense were the client and the vendor at the same time, and they inspected the results produced. In the framework of sector scientific-research institutes that were completely independent of their ministries, space programs were developed, specifications of space projects were prepared, and analyses of the projects were conducted.

The system for financing space activity was extremely labyrinthine. Until recently, appropriations for space were made from the state budget to the ministries who took part in a given project. The ministries made agreements for the completion of the work with organizations under them or among themselves. That practice gave birth to a whole array of negative consequences.

First, the sector became self-contained, and it was geared primarily to large, resource-intensive projects. Second, a good ratio was not established between the production of space hardware and the development of space technologies, especially in terms of the component base and new structural materials.

Third, no independent consumer came on the scene in the space program. The overwhelming majority of today's clients are government agencies and budget-supported organizations. They have used state money to pay for services rendered, and often that money comes from sums earmarked for the producer of a given piece of hardware.

Fourth, proper attention has not been given to the development and series manufacture of hardware that would enable a broad circle of enterprises, organizations, and citizens to make use of the services of the space complex.

In the market environment, the key components of the space program—the rocket-space scientific production associations—have turned out to be economically unsound. At one time, scientific research and experimental design work and industrial production were combined in them by directive. For that reason, many scientific production associations cannot work effectively in either area. Scientific research and experimental design work is matched up artificially to production and tries to solve new problems with systems consisting of obsolete equipment. Production, saddled with test stands and laboratories that are fabulously expensive, cannot manufacture products that are competitive in price.

One must bear in mind also that in the context of the Ministry of General Machine Building's total monies for science, "space" accounts for no more than 50 percent; for production, it accounts for no more than 35 percent. In recent years, space has not been the only activity of the main space department [Ministry of General Machine Building] and has suffered at the expense of general campaigns involving the transition to a two-level system of management and to the first and then the second model for full cost accounting, involving conversion, etc.

Thus, current management cannot choose goals properly or achieve them in an efficient manner. Such management cannot, in the strict sense of the word, be called a system. It cannot effect the integrated development of the space program in accordance with the needs of the society.

Reform of the space program presupposes optimization of management functions, separation of the managing subsystems from the subsystems being managed, freedom of action for the components of the system in the framework of the established "rules of the game," and the creation and development of information channels.

The basic principles of a new system of management of Russia's space activity should consist of the following:

definition of goals and objectives of space activity at the state level

legislative approval of budget financing

separation of the functions of client and vendor

independent analysis of space projects

The basic document in the system for managing space activity should be a State Space Program of the Russian Federation. That program should encompass work involving space systems for civilian, dual, and military use. The program would be examined by the president and presented by him to the Supreme Soviet for approval. Space projects and measures for achieving the space policy of the Russian Federation would be financed out of the budget on the basis of that document.

A key component of the system for managing space activity would be a Russian Space Agency (RSA). Special care should be taken in setting up such an agency. The agency would differ fundamentally from the traditional sector ministry. It could not interfere in the operations of enterprises and organizations. The RSA would primarily be an agency for coordinating space activity. It would have to act as a general client for all civilian space projects financed by the Russian Federation. The basic functions of the RSA would be the following:

develop a state space program;

conduct a competitive selection of space projects on the basis of independent analysis;

prepare proposals involving budgetary financing of space projects;

organize and coordinate the creation, testing, and operation of space hardware;

organize and coordinate basic scientific research involving the use of space systems;

ensure the safety of space activity and see that the activity meets the established requirements;

license space activity;

ensure that space technologies are used in the economy;

The role of the Combined Strategic Armed Forces is quite large in the organization of space activity. Virtually

the entire space infrastructure is under their control. The military accounts for some 66 percent of the space budget.

In that connection, we can make the following suggestions:

the military and civilian programs should be financed from separate lines in the budget, through different agencies;

the Space Support Systems of the Combined Strategic Armed Forces should be financed with specific appropriations, from a separate line in the budget;

a considerable part of the scientific research and experimental design work should be removed from military departments.

As for operations of satellite systems and use of the ground facilities of the space infrastructure, the first stage of reform should keep those functions with the Space Support Systems, so long as the rights of other organizations are documented. Later, parts of the space infrastructure facilities need to be transferred to civilian control in a technically and economically sound manner.

The market economy necessitates a serious reexamination of the system for distributing budgetary funds earmarked for space activity. We need to abandon the practice of appropriating money for volumes of work and to move to program-based financing of space projects. The RSA would make the order for the project and would ensure that the organization that won the competition to become head executive agency for the project received financing.

Aspects of the Joint Activity of the Commonwealth States in Space

Developing a space policy in our country is unthinkable without consideration of the sharply defined interests of the independent states that made up the USSR. The Union has ceased to exist, which has further complicated the situation in the space program, which was created and has functioned as a unified complex.

Primarily with the transfer of industrial enterprises and science organizations to the holdings of the republics, thousands of industrial-cooperation ties have been called into question, and their disruption would do irreparable damage to the space program.

The overwhelming majority of the facilities of the scientific*production bases are located in Russia. However, a number of enterprises and organizations of the space complex are also in other republics. Among them are the NPO Yuzhnoye, the NPO Elektropribor, the PO Kommunar, the PO Monolit—all in Ukraine—the PO Izmeritel BELOMO (in Belarus), and the machine building design bureau in Uzbekistan. If those enterprises left the engineering cycle for the development and manufacture of space hardware, it would necessitate reorienting space programs and adopting additional organizational, economic, and technical measures at a cost of two or three billion rubles (at 1990 prices).

The ground-based space infrastructure includes three launch facilities—Baykonur, Plesetsk, and Kapustin Yar (which is seldom used); a flight control complex that includes 15 ground stations and six shipboard stations; two landing areas on the test ranges; and several satellite-data receiving stations. It costs nearly R1 billion a year to maintain and operate those facilities (based on the change in price scale in 1991). An important component of the space complex is the launch facility at Baykonur. As much as 40 percent of all spacecraft are launched there. Without it, we could not at the moment support the functioning of satellite communications systems or execute the program associated with manned flight and studies of the planets and the Moon.

The satellites themselves occupy a central place in the space infrastructure. At present, 175 space vehicles are in operation in orbit. The satellites are in space, where the national jurisdiction of states cannot, by international law, be extended. We cannot apply to them the principle of "soil," which underlies the separation of Union property. It is extremely difficult to determine what percentage goes to the republics in the creation of the existing satellites. All of them, consequently, may have the right to use the satellites that belonged to the former Soviet Union.

A revision of the existing space programs on the basis of the interests and the financial and scientific-industrial capabilities of the states of the Commonwealth is inevitable. To count on the appropriation of funds by independent states without specific explanations of what the funds will be used for is not realistic.

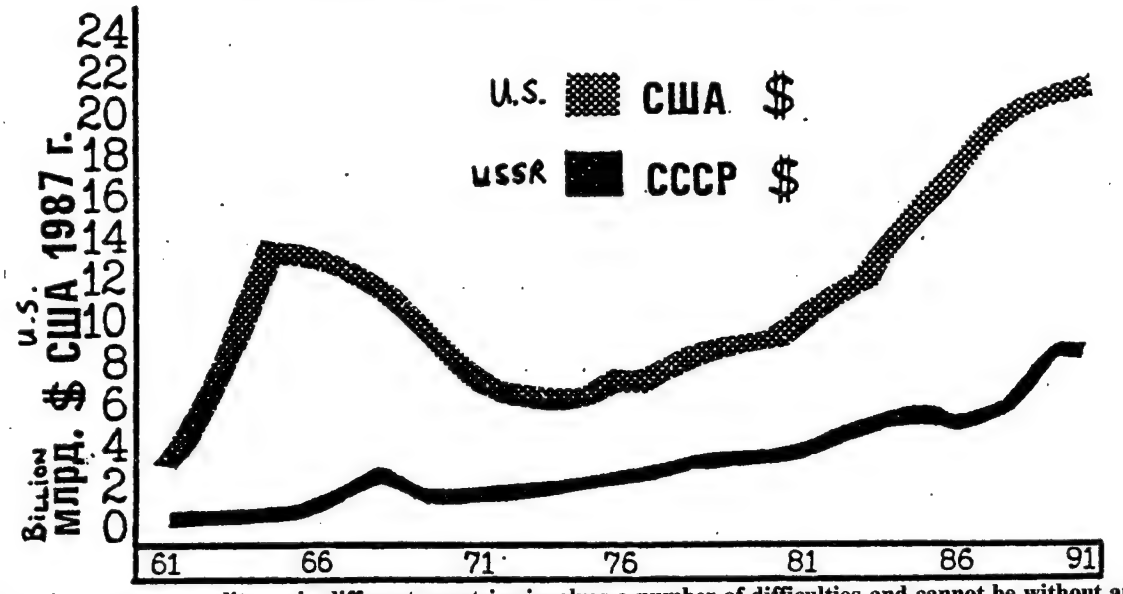
The problems arising in connection with space activity in the situation that has come about can be settled only with the aid of international legal methods, multilateral negotiations or a series of bilateral negotiations, and interstate agreements. The first topic of such negotiations must be the identification of areas of use of space systems that are of mutual interest.

Russia needs a sound space policy that includes a complex of organizational, economic, and legal measures for achieving clearly formulated goals.

Right now, the main goal consists in preserving the space potential and using it in Russia's interests. Radical reform of the space program is needed. The first step must be to create a Russian Space Agency.

Russia is impartially prepared to assume a leading role in the space activity on what is the former Soviet Union. That is based on the level of space science and technology achieved and the economic potential of the state. There is no doubt that the results of continued development of the space program will repay our efforts to preserve the space program.

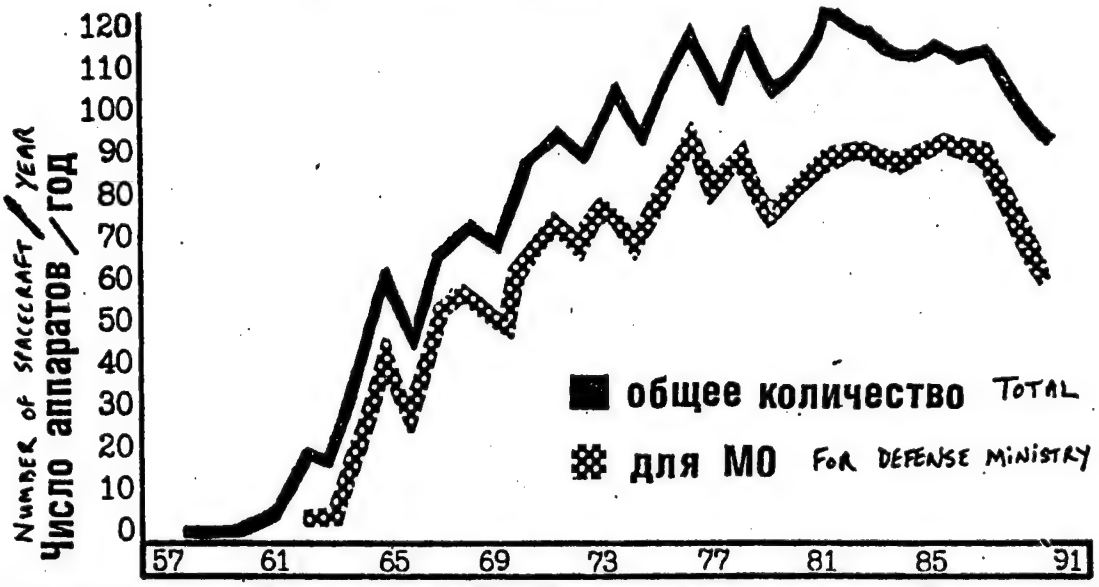
Space Program Expenditures in the USSR and the United States.



Comparing space expenditures in different countries involves a number of difficulties and cannot be without ambiguity. That is especially true for countries with fundamentally different economic systems. Moreover, a number of researchers (K. Clark among them) feel that a money-based comparison of the expenditures of the USSR and the United States is completely unreliable. The question of the cost indices of the development of the space complexes of the USSR and the United States, however, comes up all the time and can be resolved at least on the level of expert analysis.

The figure presents the graph of a comparison of space expenditures. The graph is based on data of the UNKS [not further expanded] of the USSR Ministry of Defense. The expenditures are compared with a technique developed in 1954 by M. Dzhilbert and I. Krevis. The technique is the target of valid criticism from specialists particularly because of the high degree of subjectivity involved. It is instructive that the technique was first used by the Pentagon for evaluating military expenditures in 1980. The calculations produced a ratio of military expenditures of 125*130/100 (USSR/U.S.), in percent. The unrealistic estimates forced the Pentagon to abandon the technique.

Actual Goals of the USSR in Space [1957-1991]



I. Throughout the history of cosmonautics, the USSR has strived to be the absolute world leader in space. In the absence of the proper economic and technological prerequisites, for Soviet space activity to take that direction often led to the adoption of show-window programs and the disruption of expensive projects and did serious damage to science and economic objectives in space.

As a result of the American Apollo program, we undertook a program for launching Soviet cosmonauts to the Moon, a program that, once again, was not based on the proper level of space hardware. After many billions were spent, the program was canceled. A more realistic program involving a flyby of the Moon by Soviet cosmonauts was not completed.

In the 1970's, the United States moved to a new type of space transport system—reusable spacecraft. Starting behind, the USSR began similar work and, 10 years after the Americans, created the Buran craft, which is similar to the Shuttle on the outside, but is totally useless for performing the functions of a space transport system. The 13-year development of the Energiya/Buran system cost nearly R20 billion.

II. The priority held by military objectives in the USSR space program is quite apparent in this graph of spacecraft launches.

Critics of Space Program Assailed

927Q0125 Moscow KRASNAYA ZVEZDA in Russian 19 Mar 92 First Edition p 3

[Article by M. Rebrov: "The Trap"; first paragraph source introduction]

[Text] **They say we didn't do anything "right," that our space program had a German beginning. But it was on a Russian rocket that the astronaut from Germany went aloft.**

"A scientist, like a politician, must be able to make good use of the analytical abilities of the mind, must have an intuitive sense, must focus on the actual facts only, and must draw objective conclusions from those facts. Otherwise, giving in to a free reign of the feelings, he will see the world in a distorted manner, and his intellect will stop creating and will begin to combine..." I can't say who exactly that thought belongs to—whether a servant of science or a publicist—but it came to mind for a definite reason. The director of NASA (the U.S. National Aeronautics and Space Administration) retired—Richard Truly, who was once an astronaut and who initially headed the Shuttle program in NASA and then became head of the well-known space agency. The reason for his retirement—"private clashes and disagreement with Vice President D. Quayle about the future of national space projects." In a word, about the fundamental position he took.

At about the same time (in February), there appeared in the press an extensive interview with Roald Sagdeyev, the former director of the USSR Academy of Sciences Space Research Institute (from 1973 to 1988). The academician left his post not because he had fundamental differences, but because he moved across the ocean and married the granddaughter of Dwight Eisenhower, the former U.S. president. Roald Zinurovich [Sagdeyev] discusses whether Russian needs space, whether a great but fallen power can afford to explore it. He criticizes some things, explains some things, complains about the political intrigues that have interfered with the normal development of the space program. He reproaches unnamed officials and military people, and he says that we didn't do anything "right," because we forgot what we had been taught.

I am not going to repeat the speeches of the academician at the International Space Congress in Varna, at the annual meetings of the academy and at anniversary celebrations, or at meetings with the press at Baykonur and in Moscow. I'm not going to bring up his articles and interviews in the many newspapers and journals, or ask about why the expensive Fobos project collapsed, or argue his not entirely correct assessments of Energiya and Buran (we're all bold and brave about the past). When I was reading the revelations of the prophet who now is from a foreign fatherland, two things bothered me. First, why didn't such an authoritative, unquestionably talented physicist like himself quit before he did if, for a decade and a half, he didn't share the views of his colleagues and supervisors, if he was convinced that "space was an instrument of dirty politics"? And second is a rhetorical question: Tell me, who controls your thoughts?

I expect that the reader may have some questions for me, too. I'm ready to answer them, but first a few facts that require some mulling over and some explanation. Yes, it's bad when a journalist, scientist, or politician looks out through rose-colored glasses only. And the opposite is no better—looking out through black-colored glasses. Let's try and look with an open mind on our difficult life, the importance of scientific-technical accomplishments, and the insidious insincerity of certain of our "well-wishers." And let's speak the truth about everything, honestly and directly. Hopefully in a timely manner.

So our fleet of space caravels is rather broad and varied and in no way duplicates the German V series. Our fleet consists of the Vostok, Soyuz, Molniya, Tsiklon, Proton, Zenit, and Energiya boosters. They are capable of lofting into space, to various orbital heights, all sorts of cargoes and payloads from one-and-a-half tons to 105 tons. The guarantee of success is very high—92-98 percent.

Today, we are the only ones to have a unique space complex in orbit—Mir (a base unit and three modules), which is suitable for a broad range of scientific research, engineering experiments, and the solution of applied earth-resources problems (ecology, geology, cartography, oceanology, climatology, etc.). Mir is not only a long-duration laboratory, but also an excellent testing ground. Aboard it are tested various materials, pieces of equipment, medical procedures...

"In the competition to create spacecraft of the 21st century that are capable of lifting off into space by taking off like an airplane from a runway, the lead belongs to Russia" That is the assessment of the magazine AVIATION WEEK & SPACE TECHNOLOGY. It notes, in particular, that the hypersonic ramjet tests that have taken place here, but are still only in planning in the United States and other countries, must alarm American engineers.

Remarking the significance of those studies, the magazine notes: "Specialists agree that such tests of crucial importance to the outcome of the growing international race to master hypersonic technologies. The creation of a supersonic ramjet is the main technical barrier that has to be surmounted to engineer a hypersonic single-stage spacecraft capable of reaching orbit from the ground." However, the magazine makes the caveat that "the practical significance of those tests for the former USSR is small, since its economy is in ruins, and the aerospace infrastructure is suffering considerable cutbacks and is losing financing."

Also unquestionable is our success in the creation of the Ekspress space communications system and small nuclear power supply units for spacecraft. The Topaz-2, which was exhibited in the United States, riveted the attention of specialists. As the foreign press noted, "it is

no isolated case in which Russia has preeminence, and is a real confirmation of the fact that America is behind in that field by seven-10 years." It's curious that they tried to confiscate our exhibit and not "let it out of the United States." But that's just by the by.

And I'll quote Roald Sagdeyev anyway: "Space technology and science represent a lever that can be used by any modern state to intensively develop its own equipment....Space is a sphere that provides access to the development of a whole array of areas."

We have what it takes to enter the world space market. The space structures in science and industry haven't collapses completely. the country is also capable of handling its defense problems by grounding in the intellectual potential concentrated in the research institutes, the special design bureaus, the computer centers, etc. In a word, we're not suffering from space impotence yet. That's clearly not to some people's liking. On Capitol Hill and in the Pentagon, the end of the "Cold War" has been announced, but in practice, everything they're doing there is geared to lure us into a trap.

In impeding the development of cooperation and the establishment of space business between the science and industrial centers of the CIS and NASA, the Bush administration is blocking virtually all agreements involving purchases from each other of new technologies, especially aerospace technologies. The Americans attribute such a ban to considerations of "secrecy and the danger of important strategic information leaking out." The real truth, however, is something else. The NEW YORK TIMES reported about it. The purpose is specific, although improper—"to put the space and military industry of the Union in such a state of decline that it will not be able to present any kind of threat to the United States in the future."

Aha! And if we extend the analogy between science and politics, then I think the respected academician who is expressing doubts about whether Russia needs space understands better than anyone else what this is all about and that he's playing into someone's hands. We shouldn't be simpletons. It doesn't suit us. And the danger of falling into a trap from that only grows.

And the last thing. One of the newspapers I read today reported that the Soviet space program had, as it were, a German beginning. That is easily refuted by the facts. By the way, what's also remarkable is that the German cosmonaut went into space not on a German rocket, but on one of our rockets. Perhaps it would be worth it to tell the truth about everything. And now is the perfect time.

Former Cosmonaut Kubasov Urges Centralized Management of Space Program

927Q0135A Moscow NEZAVISIMAYA GAZETA in Russian 9 Feb 92 p 6

[Interview by Anatoliy Zak with former cosmonaut Valeriy Kubasov: "How to Hold One's Ground in Orbit: A Participant in the 'Soyuz'- 'Apollo' Flight Feels That an Orbital Station is Necessary Only to the State"; the first two paragraphs are an introduction]

[Text] The state of weightlessness, so well familiar to cosmonauts, unexpectedly became a reality for the entire Soviet space program. The unwieldy, branched space giant in a single hour was deprived of a common center about which all its orbits revolved. The national budget disappeared and the ground literally went out from beneath the feet of cosmonautics—the Baykonur cosmodrome was abroad. It is obvious that in such a situation a radical reorganization of the space branch was inevitable. What kind of space program would those who have to implement it like to see?

His opinion on this matter is shared by a participant in three space flights, including under the "Soyuz"-"Apollo" program, and at the present time a specialist at the Energiya Scientific Production Association, cosmonaut Valeriy Kubasov.

[Kubasov] Our solid chain has been broken into individual links. The development of space technology and the implementation of flight is the one soundest link in the program. Second, there is the preparation of scientific programs and their implementation. And third there is the application of the results obtained in flight. Now it is necessary to bring together all parts of the program in a single department. First, expenditures will be reduced on the implementation of space programs, second, the scientific efficiency of the conducted research will be increased, and third, cosmonautics will really become useful for our society.

In the United States, in accordance with the law on space, a definite time after the ending of a space flight its results can be used by every citizen in the United States without cost. This applies to both scientific results and to new technologies which have been developed. Taxpayers, and it is precisely they who replenish the space budget, want to have a strengthened law affording access to the results of space research. Astronautics is considered a young but necessary branch and the congress, which allocates funds to NASA, will unquestionably understand that it cannot be made to pay for itself when some directions are excluded. The cited information on the payback of one program or another does not imply a specific profit, but represents the results of estimates showing that each dollar invested in space will usually yield 10-15 dollars in the form of new technologies.

It is important that NASA announces a competition for individual development projects and then signs contracts with the companies which are winners of the competition. In the same way NASA signs contracts with scientists, the developers of scientific equipment.

[Zak] You stated that the integration of space departments will reduce expenditures on space programs. In what way will this be expressed?

[Kubasov] The existence of independent monopolistic firms is leading to excessive expenditure of funds. For example, the Cosmonaut Training Center has several thousand personnel but is training only several crews per year, still using a centrifuge, and there are even two centrifuges, purchased with hard currency, costing more than 10 million dollars. This is completely unnecessary. The Americans already 15 years ago did away with centrifuges and only a few hundred persons in the United States are engaged in the training process. It is entirely unjustifiable that there are three organizations working in the field of space medicine at which hundreds of doctors are employed. All this must be consolidated. And take the production of space food. The daily ration of one cosmonaut costs 300 rubles, but since the beginning of the year—several times more than that. And why? Because an entire institute is working on this independently. In the United States only a few people are working on the production of space food, but within the walls of a single space department.

[Zak] How does such an idea of a centralized state organization, implementing the space program, jibe with our tendencies to total privatization, including in the space field?

[Kubasov] At present it is first necessary to have a state organization, and only small companies, having, for example, meteorological, navigational and communication satellites, will be able to pay for themselves because they will be able to find numerous clients for their services. However, to find a customer for an orbital station, for example, other than the state itself, is now impossible.

Velikhov's Views on Future of Russian Space Program

LD0305175792 Moscow Radio Rossii Network in Russian 1800 GMT 2 May 92

[Text] As you know, 1992 has been declared International Space Year. Along what lines will the exploration of the expanses of the universe proceed in Russia? Our correspondent Vladimir Belov asked Yevgeniy Velikhov, vice president of Russia's Academy of Sciences, to answer this question. Here is what he said:

[Begin Velikhov recording] Once again I shall be expressing my own opinion, and it might be more critical. The disgraceful situation is that while we possess such space equipment and potential we are totally lacking in communications and have very little monitoring facility. That is what is required. Our scientific programs too, although they are interesting ones, are of course disproportionate to our space potential. There are two reasons for this. On one hand all the national economic space work was to some extent the indirect offspring or vestige of military work in space. The proportions and the outlay on national economic work in space must be substantially altered.

The second thing is that, whereas previously the programs were drawn up either at the Defense Ministry or at the Ministry of General Machine-building and were then approved by the military-industrial complex, they must now proceed through the real consumer.

We have three main programs. The science program will proceed through Russia's Academy and be approved, of course, by the Supreme Soviet. The second program will be through the Ministry of Ecology and Resources. This resources program—indeed there are many of them of all types, including cartography, meteorology, ecology, and so on—they have had an absolutely neglible share of the overall expenditure. Their share must be increased many, many times over.

It is again ridiculous that we have so many satellites, while there is no ordinary GPS [Global Positioning System] receiver in the country. The latter is about the size of your tape-recorder and makes it possible to determine the location of a motorcar, truck, or anything you like. That is to say, once again we are spending nothing on ground facilities.

As for the situation in communications, there are two reasons for this. First, I think that all the communications satellites have just simply become out of date. Again very little was spent on the ground facilities. Second, the Ministry for Communications should itself be reorganized. Legislation should be far more liberal. There is no need for the manned program—there is no call for it in these three programs. As far as they go, these activities are, no doubt, interesting. We agreed that Korolyev's firm, Energiya, should find a customer. It is claimed that customers for this program can be found throughout the world.

In particular, one of the elements of this program has direct practical implemention, that is, the use of our transportation spaceship. Soyuz-T can be used as an element for the rescue of the Mir station astronauts.

The Buran question is, of course, a very difficult one. On the one hand, the problem is that Proton is our main working rocket. It does not meet modern ecological requirements. Kazakhstan will certainly firmly insist that we modernize it radically to reduce the damage it inflicts on the living world and ecology as a whole. As for the creation of a new rocket on the basis of Buran, there has been little success so far. Although it is ecologically clean it is rather expensive. We shall have to sit down and decide what to do next. As a whole, Buran is of no use either for the military or for peaceful purposes.

Comment on Sale of 'Topaz' Space Nuclear Reactor

927Q0074A Moscow EKOLOGICHESKAYA GAZETA in Russian No 11-12, 1991 p 3

[Article by A. Romanenko, doctor of technical sciences, professor: "Reactors in Space"]

[Text] Early in January 1991 foreign sources disseminated the following information: "The American administration intends to acquire a space power plant in the Soviet Union in order to develop on its basis a nuclear reactor for future spaceships. As reported by Republican Senator Domenici, the United States Department of Energy, the leaders of the USAF and the directors of the SDI program have agreed to purchase the "Topaz-2" space power plant from the USSR.

I met with Georgiy Gryaznov, doctor of technical sciences, professor, winner of the State Prize, director of work on development of the "Topaz-1," director of the Krasnaya Zvezda Scientific Production Association. Here is how the conversation went...

Q: "Can you comment on the press report concerning the American purchase of the 'Topaz-2' nuclear reactor?"

A: "First of all, about the differences between the 'Topaz-1' and 'Topaz-2' plants. The 'Topaz-1' is a plant two copies of which were put into space and which were tested for a power output up to 10 kW. The 'Topaz-2' has not been in space and has been tested only in the laboratory. The contract for its sale provides for the delivery of a ground prototype of the plant without nuclear fuel for use in carrying out an experimental research programs. Upgrading the 'Topaz-2' for making it usable in space will require considerable additional expenditures..."

Q: "What sense then does it make for the Americans to purchase the 'Topaz-2,' which has not undergone space tests? After all, it is to cost 10 million dollars."

A: "The ground prototype of the 'Topaz-2' will afford the Americans unique experimental possibilities. The results of the tests will make possible a sharp advance in planning and design development work."

Q: "In our press fears have been expressed that by selling American specialists information on Soviet space development work we thereby will assist in enhancing American military potential, and in particular, implementation of the SDI program. How do you evaluate this possibility?"

A: "In nuclear energy and space technology it is scarcely possible to find articles, materials and technology unrelated to one degree or another to their military application. However, this circumstance is no impediment to broad international cooperation. In international commercial contacts the economic gain from transactions is the most important thing. Effective methods have been worked out for control over information pertaining to technological innovations which preclude the possibility of unauthorized reproduction of technological achievements, particularly for military purposes."

Q: "Is there assurance of the safety of use of nuclear reactors in space?"

A: "Without question! I will not dwell on the technical aspects of the problem. I will say only that satisfaction of safety requirements has been placed under the control of international organizations, in particular, the UN Committee on the Peaceful Use of Space. This committee has formulated a series of restrictions under international law covering all aspects of space use of nuclear power sources."

The answers of Professor G. Gryaznov substantially supplement the overall picture of the Soviet-American transaction. However, there must be a public discussion, a call for which we also join. I would like to touch on the matter of international cooperation and the military use of space technology.

V. Pryakhin, an expert of the World Federation of Scientific Workers, was posed the following seditious question:

"And would it not be possible to unite the efforts of the USSR and the United States in organizing a unified space-based antimissile defense system?"

To the question of why such a Soviet-American system is necessary the expert responded:

"It would be useful for contending with international terrorism, in which both the USSR and the United States are interested..."

But for the time being the American side regards the SDI program as the establishment of a system capable of reducing American losses against the strike of Soviet intercontinental missiles. The American side itself does not hide its military interest. For example, R. Verga, director of the office dealing with the most important engineering and technology problems in the organization for implementation of the SDI, considers the purpose of the "Topaz-2" transaction to be assurance of an "active beginning" of implementation of a program for constructing a similar reactor, drawing upon the best characteristics of the Soviet system. R. Verga also declared that the reactors also would find military application...

The ecological aspect of use of nuclear reactors in space also is disconcerting. The United States, after the successful launching of the SNAP-10A reactive nuclear power plant in 1965, could not find a market for it and in essence financing of the work stopped. The USSR made the opposite decision—installation of reactors aboard satellites of the Cosmos series, intended for observation of the surface of the world ocean and functioning in low circumterrestrial orbits. This decision was erroneous from the ecological point of view.

In 1978 the Cosmos 954 satellite, due to accidental failure of the system for keeping the vehicle in orbit, entered into the dense layers of the atmosphere and fragments of the reactor fell on a thinly populated area of Canada. Serious accidents occurred with the satellites Cosmos 1402 and Cosmos 1900. Due to the short active lifetimes it was necessary to increase the number of their

launchings, and as a result nuclear debris was accumulated at an orbital altitude of about 800 km, containing about a ton of enriched uranium 235. Collisions of nuclear reactors in their orbits of motion with other satellites or their fragments may lead to dangerous consequences for the Earth as well! Even now it is necessary to think about controllable return of nuclear power sources to the Earth, for example, making use of the Buran space shuttle system.

'Topaz-2' Experts To Teach U.S. Colleagues

LD3103181192 Moscow ITAR-TASS in English 1127 GMT 31 Mar 92

[By ITAR-TASS correspondent Sergey Kuznetsov]

[Text] New York March 31 TASS—Russian nuclear experts will teach their U.S. colleagues to operate the 'Topaz-2' nuclear reactor, which has been purchased by the United States, the U.S. 'AVIATION WEEK AND SPACE TECHNOLOGY' magazine reported in its Monday [20 March] issue.

According to the magazine, a group of Russian scientists and engineers from the Moscow-based Kurchatov Nuclear Research Institute is expected to arrive at the university of New Mexico in Albuquerque, where the testing grounds have been prepared.

Under the terms of the sale contract, the Russian side is to deliver testing equipment to the United States for the reactor which can be used as a nuclear launcher for space apparatus.

After long disputes the U.S. Department of Defence and State Department yielded to pressure from U.S. scientists and the National Department for Aeronautics and Space Research and gave permission to purchase the 'Topaz-2'.

The reactor which has been sitting idle in St. Petersburg since last October but, so far, without nuclear fuel, is ready to be shipped to the United States, according to the magazine.

Director of the Albuquerque-based centre, Frank Tome, said the reactor would save many years of research and millions of dollars. There is still much work to be done in the United States to implement the project, and the use of the Russian technology can help shortern our research period, Tome said.

Early Mars Mission Politically Motivated, Involved Deception of French

927Q0073A Moscow LITERATURNAYA GAZETA in Russian No 7, 12 Feb 92 p 14

[Article by Yuriy Markov, test engineer, Scientific Production Association imeni S. A. Lavochkin]

[Text] Gagarin was not the first cosmonaut. And he did not fly into space at all. The Lunokhod [lunar rover] was not controlled from the Earth by specially trained operators, but from the moon by prisoners, condemned to death by the Cheka, from a special module which made a lunar landing alongside the lunokhod. The reason that the Buran landed so precisely and beautifully was because there was a secret pilot present in the cabin...

All this would be laughable. If it was not so sad.

Laughable, like any absurdity originating from illiterate and unrestrained fantasy. Sad because the dark lies by the government concerning this branch, which was secret even without the lying, gave and still give food for speculation and not the "fruits of education."

There are still more than a few events in our cosmonautics which await their "moment of truth." Here is one of them.

The great Martian opposition of 1971 approached.

American specialists outfitted the Mariner 8 and Mariner 9 spacecraft for flight. These intelligent machines, each with a mass of one ton, were to become artificial Martian satellites and select sites for landings of future Vikings.

We also joined the Martian race.

The Lavochkin enterprise, in collaboration with related scientific research institutes and design bureaus, developed the Mars 2 and Mars 3 orbital landing craft, each with a mass somewhat less than five tons, to be launched by a Proton booster.

Both stations were crammed with a major package of scientific instrumentation designed for a thorough, multisided exploration of Mars. And only one experiment was to be of a very special character: study of solar radiation in the meter wavelength range. It was represented aboard the vehicle in the form of the French electronic instrument dubbed "Stereo.". This was the first foreign instrument carried aboard a Soviet interplanetary station.

Thus, the French side, as scheduled, fabricated and supplied to the Soviet side two "Stereo" flight assemblies. But here politics intervened.

The launching of the Mars 2 and Mars 3 stations was planned, in accordance with the calculations of ballistics specialists, for 19 and 28 May 1971 and arrival in Martian orbit was planned for 27 November and 2 December of that same year. And at this point it became known that the American Mariner 8 and Mariner 9 vehicles, launched even in late May, would outstrip them on the way and would become artificial Martian satellites several days earlier, thereby taking the priority for their country.

Then a decision was made "on top": immediately fabricate a "clean" satellite—a third Martian vehicle without a landing module. Launchable as early as possible, considerably lesser in mass and imparted a greater

impulse during launching, this orbital module should become the first artificial Martian satellite and take the priority away from the Americans.

Again political ambitions "put the squeeze" on science. It was decided to place one "Stereo" assembly on the "clean," unplanned satellite, and the second in the orbital module of the Mars 3 in order that the measurement base would be greater.

The Soviet Martian satellite was launched on 10 May 1971 and the American Mariner 8 on the same day. Both these launchings were failures. But the world learned of this in different ways.

On the day of the accident a NASA representative reported (and this communication was immediately disseminated via all world information facilities) that "five minutes after the launching the second stage of the Atlas-Centaur booster went out of control at an altitude of 92 miles above the Earth and together with its payload fell into the waters of the Atlantic 900 miles to the southeast of Cape Kennedy."

In our case nothing failed, but... One after another the three stages of the Proton booster did their job, the rocket propulsion module "D" ("E") successfully underwent its first launching and the nosecone entered the computed circumterrestrial orbit. The second launching of the "D" was to occur after one and a half hours and the space vehicle was to be pointed in the direction of Mars. But what happened? The set time elapsed and no second launching occurred.

I will never forget the pale faces of representatives of the Pilyugin enterprise, those who had developed the control system, and our control specialists, who with unsure hands fumbled with the technical documents. It was found that a serious blunder had been made by the developers of the on-board computer during the setting on the ground of the device determining the time of firing of the propulsion stage engine. Due to a mixup in the method years were set instead of the stipulated one and a half hours...

Thus a properly functioning vehicle was lost. And at the same time, our priority and the French "Stereo."

Both the Mars 2 and Mars 3 were successfully launched at the designated time and the public was properly notified of this in traditional TASS communications. There was, however, profound silence on the loss of the first Martian satellite.

French specialists began cheerfully and joyfully to receive scientific information from their "Stereo" carried on the Mars 3. But why was the Mars 2 silent? Our answer was entirely simple and dignified: the instrument carried on this vehicle simply did not click on. Although, to be sure, it was the fault of the Soviet side.

The Mariner 9, launched on 31 May (according to the American calendar) after repeated postponements, on 14 November 1971 became the first Martian satellite. After 13 days a second artificial satellite appeared at the "red planet," and after another five days—a third.

The Mars 2 descent module experienced misfortune: its on-board instrumentation was not triggered and it fell like a rock on the planet surface. However, the Mars 3 descent module, for the first time in the history of cosmonautics, made a soft landing on the surface of the planet Mars, but after landing the videosignal was transmitted for only 20 seconds. But all the same we did retain some priority.

Scuttling of N-1 Rocket Program Described

PM1404114792 Moscow Teleradiokompaniya Ostankino Television First Program Network in Russian 0825 GMT 9 Apr 92

[Video report from the "What Stars Are We Flying To?" documentary]

[Text] [Narrator] We had hoped to use this rocket to land cosmonauts on the moon before the Americans. It is only now that we are able to show you our failed dream of the moon—the N-1 rocket. Work on it was begun under Korolev, but the flight testing took place without him. The N-1's four launches ended in accidents. This was a common phenomenon for that period of rocketry development. It was what initially happened to all our rockets—even the most reliable ones. But we were in a terrible hurry. This was the last flight of the N-1. Sergey Aleksandrovich Afanasyev, minister responsible for rockets. Academician Mishin, chief designer of the N-1. The rocket would explode 20 seconds later. All work on it would be wound up. Mishin would be removed from leadership of the design bureau. Vasiliy Pavlovich Mishin was Korolev's deputy and succeeded him after his death. When the N-1 program was wound up, he found himself out of a job at his beloved enterprise, and switched completely to working as a lecturer at the Moscow Aviation Institute. We spoke to the academician here, beside a lunar landing module which never made it to the moon.

[Reporter] What is your opinion—why was the N-1 program wound up and who needed this to happen, who was to blame?

[Mishin] I think the main culprit was Dmitriy Fedorovich Ustinov. The reason for winding up the program—at least from his standpoint—was that the Americans had beaten us to it. This was a turning point in his career. Prior to this, he had not been a Politburo member, much less defense minister. He reached these positions after winding up the program. Afanasyev could not care less. All these failures were affecting his career. So he did not oppose winding up the N-1 program. Glushko had been against its development from the very outset. But I am sure that the N-1 would have flown successfully, because at the time the program was wound up the engines had been more or less perfected—they were to be further refined subsequently. And, ultimately, the success of any

flight is determined by the engines. Getting the engines right takes time. And Mikhail Dmitriyevich Kuznetsov—who was developing the engines—simply did not have that time.

[Reporter] Tell me, how much did the N-1 program cost?

[Mishin] At the time I left it was around 3 billion. That was the total amount written off. After Korolev died, I was in a no-win situation. But I was probably to blame to some extent for the fact that not all the rockets worked.

[Narrator] Dmitriy Fedorovich Ustinov headed the country's defense industry under Stalin, Khrushchev, and Brezhnev. He was one of the people who set up the Soviet rocket industry, and he did more than anyone to reinforce it. He often visited factories, test ranges, and design bureaus, and naturally knew the real state of affairs in the sector. But Ustinov's knowledge about the state of affairs in the top echelons of power and the general secretary's abiding space ambitions was equally good. Brezhnev once said to him: "We should prepare for a manned mission to the moon straight after the first successful launch of the N-1, without waiting for it to be finally developed." Those words were effectively the rocket's death warrant. Ustinov realized that a successful N-1 flight would mark the start of an unprecedented space adventure—and just at the time when confidence was growing that the rocket would work, it was written off. One launch-ready rocket and several that were almost ready were cut up and junked. Appropriate arguments demonstrating the flawed nature of the main principles behind the N-1 were, of course, drawn up. Who can say now just what made Ustinov reach this decision? Fear for the country's prestige, for the lives of the cosmonauts, or for his own career? Probably all three. And these enormous and fantastically powerful spacecraft turned out to be fragile and helpless in the face of a mere stroke of the pen. This is not just a burial place for 3 billion. Here lie years of intense work, ideas, solutions, hopes... and wrecked careers. The top-level decision to write off the N-1 stated that maximum use should be made of all the rocket's components. And so it has. They were turned into summerhouses, dance floors, and pig sties.

Complaints of Pollution Caused by Spent Rocket Stages

927Q0100 Moscow ROSSIYSKAYA GAZETA in Russian 22 Jan 92

[Article by N. Dudnikov, Yamalo-Nenetsk Republic, under the rubric "The Correspondent Is in Touch": "The Nenetsk Family Against the Backdrop of Space: The Tyumen North Is Becoming an Ecological Dumping Ground"]

[Text] We are going through times in which an immense amount of paperwork is shedding its "Secret" stamps like rustling leaves. And it's no news to the whole country, much less to those in the North, that two rayons in Yamalo-Nenetsk Republic are where spent rocket parts have fallen and continue to fall. Anyone who may not have gone to the North, but who has gone to the Baykonur launch facility has seen what kinds of parts they are. The crimson nose fairing and the strikingly large, cigar-shaped fuel tanks.

But it's not idle curiosity that has brought me to the cradle of space glory—it's some purely prosaic topics.

For example, do the "chunks of metal" that fall to our Earth from the celestial heights contain radioactive contamination? I was assured that no one at Baykonur is more capable of answering that question than Col V. Doronin. And he staked his life on it when he said that their equipment doesn't carry such dangerous stuff.

Of course, Doronin did admit that there is an exception to the rule—the Proton vehicle. It burns aggressive fuel components. And when a stage separates, as much as 200 kilograms of a substance that is more a poison than a balm to the environment pours out into space, which means into the water or onto the land. He asserted, however, that such rockets do not lift off from Baykonur.

Well then, where do they lift off from? From Plesetsk, perhaps?

"No, no! We don't have anything to do with the Protons!" said the deputy chief of staff at Plesetsk, V. Vasilenko, disowning the rocket.

You don't know who to believe. What does the photo they gave me at Baykonur mean in that case? It captures a moment in time when the Proton, engulfed all in clouds of vapor, is being readied for its leap into space.

Could it be that those launches were in the past? Still, it's a fact that the Protons were used. In which case, one would like to know where and in what amounts did their remnants, to the sorrow of all living things, spread contamination? You don't suppose it was in Uvatskiy Rayon, do you? The chairman of the rayon soviet, Yu. Svyatskevich, recalls how in 1987 people in military uniform suddenly appeared and literally combed the rayon. There were a lot of them, and they were searching very carefully for something. Lost in conjecture, Svyatskevich submitted a deputy's request for information to D. Yazov. The minister of defense refused to satisfy Svyatskevich's lawful curiosity, but Yazov did assure him that such an incident wouldn't happen again.

And essentially, I, too, received similarly "exhaustive" answers. Plesetsk specialists disputed even the term "passive proving grounds" with regard to the Tyumen Oblast. In their opinion, an area where spent rocket parts fall cannot in any way be called a proving ground. But the *Soviet Encyclopedic Dictionary* reports the following on that count: "...a plot of land or sea intended for testing weapons, weapons systems, or equipment."

I'll admit that the first two definitions don't have anything to do with what we're talking about, but isn't a rocket, even when used for peaceful purposes, equipment? And what, if not a proving ground, do you call a

plot of land where economic activity is forbidden and which has become simply a dumping ground for chunks of spacecraft metal?

But don't think that just because it's a dumping ground, there's no method to the madness. Two or three days before a launch of a spacecraft, the military department sends a telegram to the local Soviet on whose territory the prsent from space will land. All parties agree that everyone who works in the immediate vicinity of the danger zone must evacuate temporarily. But that system of precautionary measures sometimes misfires. For example, about two years ago, Plesetsk required that a herd of reindeer on the Yamal Peninsula be driven some 40 kilometers from a given region. The cosmodrome erred in its calculations by exactly that amount. And the "pig" (or, if you will, the spent part of the launcher), which weighed 5-6 tons, came crashing down right next to the tent of herdsmen. After that, the local authorities again demanded that the dumping ground be moved to somewhere in the Kara Sea. The official response was this: that's not desirable. Because launches at other inclinations don't ensure efficient use of space vehicles. But venomous tongues asserted that the department simply doesn't have anybody smart enough to adjust the calculations of the legendary Korolev.

What are things like now? In a region we'll call "Tobolsk" (it's 80 kilometers from Uvat), the taiga and the swamps are literally bristling with old and new rocket fragments that didn't burn up in the dense layers of the atmosphere. In the meantime, in some remote corner of Tobolsk, the promising Kalchina oil field has been opened. Within a year or so, they'll lay pipelines there. It's not hard to imagine the tragedy that could result from an inaccurate landing of an spend launcher stage.

Seeing that the words "ecology" and "sovereignty" have come into fashion, the local Soviets began considering them and even trying them out. Did they demand compensation for losses from the cosmodromes? Right now, they're laughing at themselves, recalling how they smacked their lips in anticipation of the millions in profits they'd get from their cluttered territory. Nothing, of course, came of it. And it wasn't because of the stinginess of the department. The sector that has absorbed the leading edge of science and embodies technological progress is, as we know, not only ruled with an iron rod, but is also ill treated. The minister of defense allowed Plesetsk, specifically, to loosen its purse strings only in the event of a direct loss. That is, only if the rocket parts slammed right into the herd.

And in all other cases? "Where possible, render practical assistance with material and technical resources to fortify the social sphere..." Such pledges were made to the Uvat Rayon Soviet by the management of the Plesetsk cosmodrome a year ago. But apparently no opportunity has presented itself.

There was, it's true, a more intriguing paragraph in the document, from which it followed that the military unit 13991 promises to begin collecting and utilizing the spent booster parts in the area of their fall. Alas! The dumping ground continues to grow. Here are some figures that will help you to imagine its size. Over a period of 30 years, the rayons of Tambeya and Yar-Sale have been used as a discard area 130 times. Next to reinforced, light-weight fairings rest chunks of metal that weigh five tons or more.

Baykonur, as we know, does not discard "its" chunks of metal. Its special subunit has been working in the Tomsk Oblast for many years now. From the rocket stages they take out the precious metals and then cut them up and take them away. But the Northerners, who are sick and tired of the Plesetsk doubletalk, have decided themselves to put the scrap metal of space onto the path of conversion. They have fashioned the nose fairings into tent frames. And a booster fuel tank at the Rossiya reindeer-breeding sovkhoz, for example, is being used to store feed.

Some hotheads, of course, still want to go farther—they are demanding that rocket launches from Plesetsk be banned. Even though they understand that without satellites today, we're not going anywhere.

But nor do they want any longer to sit and watch someone turn their part of the country into a latrine for our peaceful space. And aren't they right?

Commentary on U. S. Spy Satellite Programs

927Q0075A Moscow KRASNAYA ZVEZDA in Russian 5 Feb 92 p 3

[Article by M. Rebrov, KRASNAYA ZVEZDA scientific reviewer: "Through the Keyhole—From Space"; the first two paragraphs are an introduction]

[Text] "You spend millions for armored cars, armed guards, complicated safes and security systems, you cover windows with metal shutters and safeguard your telephones from bugging, none of which comes cheap. And you also spend many millions on the protection of buildings, transportation facilities and other safety measures, assuming that you are being observed from close up. But you are helpless against sharp "eyes" and keen "ears" which track you from space"...

I read these lines in the New York LEADERS. I do not know what is more significant in those lines: intriguing information or a dire threat. One thing is for sure: the theft of "terrestrial" secrets by means of space technology has not become simply a fact—it has become an everyday occurrence. The American electronic espionage network covers the entire planet. And this also is a reality of our times.

The space surveillance era began for the United States in 1960 with the orbiting of the Discoverer satellite. It was developed by order of the CIA for photographing the territory of the USSR. In the years which followed the attention of the secret services to space increased. A

program with the code name Keyhole appeared, and together with it, also the satellites KH-8, KH-9, KH-12, more perfect in design and survey quality... Other names also appeared in launching reports: Big Bird, White Cloud, Ferret, Lacrosse, Hitchhiker... Officially nothing was reported concerning their capabilities and purposes, all the information was Top Secret and published only in special bulletins for official use. But then individual pieces of information began to leak to the press, making clearer what was concealed behind intriguing names like "Big Bird," "White Cloud," "Chorec" and others...

It was found that each of them had a definite sense. Some satellites photographed foreign territories, others carried out electronic surveillance, still others were intended for the registry of nuclear shots, and finally there were those for tracking the movement of ships and submarines in the ocean... It became clear that later modifications of the Keyhole spy satellites were outfitted with instrumentation now making it possible to observe 80 percent of the territory of the CIS, to obtain a clear image of individual objects, to intercept conversations passing through telephone and radio communication channels.

To the displeasure of the CIA the fact was publicized that about 40 American vehicles are constantly present in space which around-the-clock perform difference surveillance operations. "Spy satellites," acknowledges the British TIMES, "are able to collect information in virtually any weather, day and night. They can not only scrutinize and sense the land, sea, ocean and atmosphere, but also glance beneath the land and under the water, 'poking around' to see whether something is going on and has been camouflaged, that which cannot be seen with the naked eye."

The Pentagon has not refuted a single communication in the press, unexpected and undesirable for it, concerning the activity of the so- called National Security Agency (NSA). This is an arbitrary name. The real name is kept strictly secret. But, as the WASHINGTON POST wrote, it is precisely this agency which controls and plans espionage from space. Among all the specialized espionage organizations and services in the United States it is this agency which has the largest annual budget. Billions of dollars are annually expended just on the development, production and launching of special space vehicles. The maintenance of the enormous network of surface stations, ships and aircraft for tracking and surveillance, satellites and data processing centers associated with them, cost the American taxpayers a sum exceeding 50 billion dollars.

How small an "object" can be seen and interpreted from space? It seems to me that a straightforward answer to this question would eliminate many other "whats," "hows" and "whys." The American space expert Professor J. Pike does not conceal the fact that a spy satellite is capable of transmitting photographs on which objects measuring less than one meter are visible. Seemingly completely open. However, this statement is evasive and inexact. What does less than a meter mean? Both 90 centimeters and 5 centimeters fit into these "limits." For a system of the Lacrosse type (cost 500 million dollars), and especially for the equipment which is to replace it, the figure "100 cm" must be reduced by a factor 3-4. As written in the above-mentioned TIMES, it is possible to make out automobile license plate numbers on photographs taken from space.

Times are changing, notes the reader correctly. Confrontation is giving way to cooperation, new arguments are appearing and now it is scarcely necessary to show that the past was a terrible mistake. No more! I am not going to discuss the past any more; I am talking about the present. And here everything is much more complex. The arguments and time have both possibly changed, but strategic goals have not. An example of this is the attitude of the United States toward our proposals on a global defense system instead of the SDI.

The American military-political leaders, notes the Reuter agency, has intended to modernize not only strategic defense systems, but also to develop new space facilities for surveillance and espionage. Reference, in particular, is to third-generation satellites of the DSP-2 series. Their fundamental difference is the positioning in the telescope focal plane of a matrix of 6000 photodetectors operating in two parts of the IR spectral range.

The response of the new photodetectors, notes the foreign press, will make it possible to detect not only the launching of ballistic or operational-tactical missiles, but also the flight of aircraft with an afterburner operational mode of the engines. It is planned that satellites of the new generation be positioned over the surfaces of the Atlantic, Pacific and Indian Oceans. Their on-board apparatus for laser communication and data transmission will have increased cryptosecurity and noise immunity. Plans for the development of a space tracking system provide for an increase in satellite mass, lifetime (up to seven-nine years) and number of photodetectors (up to 24 000).

DSP satellites were used during the war in the Persian Gulf zone. Being in a stationary orbit and rotating about its longitudinal axis with a velocity five-seven revolutions per minute, they supplied revised information each nine-12 seconds. The data which were obtained were compared with those registered in the computer memory. However, as noted by foreign military specialists, the DSP satellites could not provide highly precise computed coordinates of the points of damage of Iraqi missiles. The reason was that the seven-minute approach time of the Scud missiles was too short for complete processing of all the information arriving from the satellites.

By means of space technology the Americans prepared digital terrain maps for programming the flight of Tomahawk winged missiles and in five days produced new maps of Kuwait. For on-line use of data collected by military satellites, already a month after the onset of

military operations the United States deployed in the Near East about 40 satellite communication stations and a number of special data processing points.

However, we will lay aside events which are now history. Now (this day and this hour) there is still another DSP in geostationary orbit (No 16). It began to operate on 25 November 1991. The spy satellite was put into space by the crew of the Atlantis shuttle. The group of six astronauts included an army intelligence officer. The American press said that this mission was secret. But the Defense Department could not completely conceal its intentions. It became known that in the course of the 10-day flight the crew carried out tests of two types of surveillance cameras, on the capabilities of which the Pentagon remains silent.

There you have some food for thought....

Correspondent Visits NASA Sites, Argues Benefits of U.S.-Russian Space Cooperation

927Q0134 Moscow IZVESTIYA in Russian 17 Apr 92 Morning Editio np 6

[Article by Boris Konovalov: "We Lost the Space Race. It's Time to Begin Working Together"]

[Text] "Our organization," I was told by John Klineberg, director of the Goddard Spaceflight Center, "was created on 15 April 1959 in response to the success of your first satellites. We started with 157 staff members working on the Vanguard project. Now our center, which bears the name of a pioneer in U.S. rocket hardware, R. Goddard, is one of the largest in the world. We have 13,500 staff members, who do work across a very broad front of space-related scientific and applied research."

However paradoxical it may sound, American astronautics owes its own success to, more than anyone else, the Soviet Union. Announcing that "socialism is the launch pad into space" and transforming the space program into ideological proof of the advantages of the socialist order, we let the generous "genie" of space appropriations in the United States "out of the bottle" for the counter-struggle.

Now the annual budget for the Goddard Center, which is located in a suburb of Washington, is $2.5 billion. And it is only one of 11 science centers of the National Aeronautics and Space Administration (NASA). The total annual spending of the United States on astronautics (including military astronautics) is now at more than $30 billion. At the current exchange rate for the dollar, that's almost 6 trillion rubles [R]. Last year, when things were still good for our space program, the spending for all the space program's needs, including military space, was around R7 billion. This year, the spending has been cut.

So now our "contest" with the Americans is reminiscent of the competition of the heroine of Ilf and Petrov, the "cannibal Ellochka," and the daughter of the American billionaire Vanderbilt. The end of the military mindlessness that led to the ravaging of our country is set; Russia's military missiles are no longer aimed at the United States. But has the "cold war" between astronautics and cosmonautics ended?

Unfortunately, it's still too early to say. The Goddard Center is still the only center that is conducting a rather serious joint space project with us. An instrument from that center, the TOMS, for mapping the Earth's ozone layer, is in operation aboard the Meteor-3 satellite. The science director of the program, Jay Herman, told me that the American specialists are very pleased with the results; they have managed to study in detail the dynamics of the seasonal appearance and disappearance of the "ozone hole" over Antarctica. On the whole, that project is very important for all of mankind.

But how much does that project "weigh" in the overall budget of the center? Hundredths of a percent. Of the 13,500 specialists from various countries working there, there is only one Russian at the moment, and his arrival was made possible thanks only to the truly heroic efforts of well-wishers. And I was the first journalist from the CIS countries to have visited the center.

On the other hand, our astronomers have not sent a single request for specific research to the Goddard Center, from which, in fact, the largest exoatmospheric telescope in the world, at 2.4 meters, is controlled. And yet, they're ready there [at Goddard] to give us the opportunity.

I was surprised to find out that there are no permanent communication lines between the two manned-flight control centers in Kaliningrad and Houston. The crew of the Atlantis, which was recently in space, tried long to establish contact with the Mir station through amateur radio operators. Our cosmonauts, A. Volkov and A. Kaleri, ignored a request that they get on the line with participants of the annual all-American space symposium that was taking place in Colorado Springs. Were they really so overloaded with program-related work to get on the line?

After all, that traditional symposium is extremely important in terms of forming the opinions of the U.S. aerospace community. We don't have anything like that symposium, which has been arranged eight times already by the U.S. Space Foundation. Political figures, NASA administrators, scientists, military people, and representatives of the space industry gather there and set up a huge exhibition. Much hinges on their collective opinion.

And it should be stressed that this last time, they were very favorably disposed toward us. Musa Manarov, who had spent a whole year aboard the Mir station, was greeted with applause. Out of all the cosmonauts from the other countries, the Frenchman Jean-Louis Chretien, who has twice been aloft aboard Soviet systems, was chosen to give a paper. The IZVESTIYA correspondent was also invited to the symposium. The opening address

was given by the famous physicist Edward Teller, one of the creators of America's thermonuclear weapons and an active participant in the cold war. And that venerable old fellow spoke about how our world has changed radically, and serving as one of the sources of that change were the unarmed people of Russia who rose up in Moscow in that animated circle before the tanks during the August putsch. That confirmed opponent of the Soviet Union was now asserting to those gathered there the need for space cooperation with the new Russia.

The host of the symposium, the U.S. Space Foundation president, Richard MacLeod, told me that most of the aerospace specialists favor cooperation with us now. The fastest way to do that, in his opinion, is through the universities, which are working on how to convert the Shuttle fuel tanks into a useful space laboratory. At present, those giant tanks, after expending their fuel, are merely jettisoned, and they burn up in the atmosphere. More difficult, but also possible is the exchange of cosmonauts, as well as the use of our technologies and rockets. And even joint work in the development of the Strategic Defense Initiative (SDI) is not far-fetched today.

With Russia no longer seen as an enemy, it is beneficial to NASA now to use us as partners. It must be said that obligations to allies constitute one of the pillars of financing of American astronautics. Our military-industrial complex never allowed its allies to take part in the design of space systems. Individual instruments, foreign cosmonauts—yes, of course. But never any structural elements. On the Shuttle series spacecraft, one of the crucial elements, the manipulator (the mechanical arm that's used to send satellites into space from the cargo bay and, conversely, to bring them back in) was made in Canada, not in the United States. Aboard Atlantis, whose launch I had the opportunity to see, was an atmospheric research laboratory carried in the cargo bay. It was produced by the European Space Agency and Japan. It cost $50 million. The Americans launched it for free, spending more than $400 million for the mission. According to the research plan, that apparatus must go back up 10 more times. That means that NASA and the U.S. aerospace industry will get orders for 10 more flights. After all, breaking one's obligations to one allies is not a good thing to do for such a mighty power like the United States.

That is why for NASA, Russia as a partner, whose participation in space projects would strengthen NASA's position when it advocated its budget before Congress, is becoming potentially useful today. In Washington, I spoke with the deputy director of NASA, Samuel Keller, who had just returned from Moscow, where he had headed a delegation that was negotiating with NPO Energiya.

"We are pleased with the visit," Keller told me. "The Russian specialists spoke with frankness, and we got answers to all the questions that were of interest to us. The main purpose of our trip was to study the possibility of using Soyuz spacecraft for emergency evacuation of Freedom station crews if such a need arose. Since a crew would consist of four to six people, that would necessitate two Soyuzes. Their well-verified length of service in orbit is six months. We knew that that could easily be extended to a year. But we wanted to have a craft that could be kept moored to the station in a safe-hold mode for five years. That's problematic. Which is why we're now doing a careful study of the information we received."

As you can see, with the question framed in that manner, the possibility of both a positive and a negative answer is built in. And that's with the Shuttle-series spacecraft working in orbit now just six to eight days. But they are asking five years of reliable operation. It's clear that new developments are needed for that.

Although I'm not a specialist, and simply a journalist who is pretty familiar with space hardware, it's obvious to me that there may be alternative solutions. The existing "nose" docking port of the Mir station makes it possible to have four other modules, in addition to Soyuz, in orbit. In the future, the possibility of docking with Buran is called for, and that means, in theory, also with Shuttle-series spacecraft. But a seven- to eight-day Shuttle mission costs an average of $400 million, and the craft itself costs nearly $2 billion. A Soyuz, together with the rocket, at last year's prices, costs about R20 million. Even if you were to factor in a manifold price rise in 1992, it's clear that that's still a relatively cheap system. And after all, the Shuttle certainly won't be required each and every time for a crew change on the Freedom station or for delivery of cargoes. In many instances, a Soyuz would be sufficient. Which means, five years in orbit won't be required, and virtually any ready craft could be used.

The Freedom station itself is conceived rather extravagantly. Just to assemble it completely will take nearly five years and 17 launches of the Shuttle craft carrying sections of the station. The total cost of the project comes to roughly $70 billion. To lower that cost some for American tax payers, the station is planned as an international station. The European Space Agency is making one module, Japan is making one, and the Canadians are taking part in the project. But that won't make the project that much less expensive for the United States. If the Soviet Energiya rocket were used to put the station sections in orbit, however, that could reduce the cost of the station considerably.

But that would necessitate removing all the restrictions existing in the United States on the use of our high-level technologies and, second, recognizing us as an equal partner and paying us at world prices.

U.S. president G. Bush took the first, very important step in eliminating the restrictions—he allowed the acquisition of our Topaz-2 nuclear reactor and our economical electric thrusters for space vehicles. But at what price? In all, for $14 million. Even according to the

estimate produced by the NEW YORK TIMES, which was conservative in its calculations, those technologies actually cost hundreds of millions of dollars. Why, in that bargain alone, the United States made up for a considerable part of the humanitarian aid that it is giving us. Some are now crying out that we are selling out Russia cheap.

But things aren't all that simple. If that $14 million were to be converted to rubles, it would be almost half of the Russian budget planned for this year for the national economy sector of space. That's the first thing. Second, we must understand that there are 6.5 million unemployed in the United States, and tens of thousands of them are specialists from the aerospace complex, which is now experiencing a decline in production. In those conditions, the acquisition of our technologies at low prices vindicates the position of the Bush administration, Bush having taken a risky step during this, the preelection campaign.

But, of course, a beggarly amount is good only for a first step, to get things going. Henceforth, that kind of thing mustn't be tolerated. And ahead, after all, is not only the Freedom station, but also the lunar and the Mars programs that have been announced by President Bush. For those programs, we already have a ready-to-launch rocket—the Energiya—something the Americans don't have. And the recently created Russian Space Agency and our parliamentarians would probably do well to put together a serious, well-argued memorandum on the advantages of the use of our space technologies for international projects. Everyone is looking for guarantees for Western credits, but they're already here—the use of our space program. Yes, we've come by that program through deprivations, low wages, and much more. But now it can repay its loan to the people, if the West is serious about helping us.

During my trip to the United States, a speech given by the American astronaut and congressman Bill Nelson at the symposium at Colorado Springs made a big impression on me. He said that Americans are now working quite successfully with former enemies, the Germans and the Japanese. But to many, cooperation with the Russians still seems dangerous. But for peace on the globe, that cooperation is extremely important. Nelson said that a joint mission to Mars with an international crew that would include a Russian and an American is a dream that we are all in need of right now.

President G. Bush notes another side in arguing the need for a mission to Mars—mankind, youth needs a spiritual dream, the opportunity to face never-before-seen difficulties and to overcome them. Today, in our poor, ravaged country, a mission to Mars seems far-fetched. But why would it be unachievable is we were in the "same boat" with all the civilized countries?

Right now, in this 500th anniversary of the discovery of America by Columbus, people in space circles love to draw a historical parallel. Yes, exploration of space is expensive, but in the context of the Spanish queen Isabella's capabilities at the time, it's not any more expensive than the price she paid Columbus for the expedition. Space is expensive. But the world will grow richer for it. And if we take our proper place in the world community, participation in any and all space projects will be accessible to us.

U.S. Said To Be Exploiting Weak Position of Space Program

PM2104145692 Moscow KOMSOMOLSKAYA PRAVDA in Russian 15 Apr 92 p 2

[Special correspondents S. Brilev and St. Kucher report, plus unattributed postscript: "How We Helped the United States To Economize on the SDI [Strategic Defense Initiative] Program"]

[Text] Washington and Moscow—Talks on the use in the United States of the Topaz-II nuclear reactor, developed at the Kurchatov Institute, began a few months ago. The reactor's capacity is insufficient even to light a few apartment blocks, but perfectly sufficient to power a spacecraft on a long interplanetary expedition—to Mars, for instance.

The Americans, incidentally, have been developing a small reactor of their own, though completion of work on this reactor is not envisaged before the next century.

Academician Nikolay Ponomarev-Stepnoy claimed at that time: It is a question only of **participation** by our specialists in the preparations for a flight to Mars; we do not intend to sell the reactor. Two months later it was sold.

These plans were revised only recently. At a news conference in the White House two high-ranking generals from the Pentagon (at the request of the president's assistant press secretary Laura Melillo we are unable to give their names) announced that the U.S. Air Force is buying Topaz-II for $7.5 million—apparently in order to help Russia. Congress and ex-President Ronald Reagan have more than once expressed the wish that the administration support the reforms in the former USSR more actively. The administration has even announced the lifting of the ban on trading in high technologies with the CIS states.

It is said that U.S. experts, traveling round the CIS countries, compiled a list of 3,000 items: Some technologies simply do not exist in the United States, and they are lagging significantly behind in the development of others.

Let us return, however, to Topaz: The Strategic Defense Initiative Organization has already requested permission to use the reactor in its program, which was so criticized by Soviet leaders only a few years ago. The Soviet Union usually demanded assurances from foreign partners to whom it sold space or nuclear technology and equipment

that they would be used only for peaceful purposes. This is how Glavkosmos [Main Administration for the Development and Use of Space Technology for the National Economy and Scientific Research] acted, for example. Time softens principles, and anyway Topaz was sold without its participation.

Across the ocean they are so confident of the complete collapse of our space program that at a session of the House of Representatives it was stated that almost all Soviet space equipment and technology has been offered for sale at knockdown prices. "Knockdown" to such a degree that NASA could buy up not only the orbital space station Mir, but also Energiya....

"We do not intend to sell anything at knockdown prices," O. Firsyuk, deputy chief of Glavkosmos, assures us. "And there is no question at the moment of selling Mir. And in general there are lots of serious contradictions in our space relations with the Americans.

"The Americans began to develop the world space market in the late sixties. Communications satellites at once became the most expensive commodity, costing up to $200 million. Here, it is true, we were unable to compete with the Americans. The cost of producing and launching remote sensing satellites is considerably lower. It is also possible to make money out of materials technology and manned space flights....

"The Soviet Union was becoming a dangerous rival, it seemed. After the Challenger disaster, Shuttle flights and, consequently, the launch of satellites by them, were temporarily halted. The Europeans rushed into the market with their Ariane rocket. Suddenly we appeared on the scene also, with slightly lower prices. But things did not turn out as we expected. It turned out that first of all we had to obtain **a license from the Americans for the right to launch satellites on behalf of third countries.** The law forbidding the export of space technology and facilities to the now ex-socialist countries continues to operate in the United States. And in virtually any satellite—British or French, Brazilian or Canadian—there is at least one American component, be it ever so small. This means that we do not have the right to launch these satellites without having obtained a license from the U.S. State Department.

"Right now we are competing for the launch of two South Korean communications satellites in which there are also American components. Glavkosmos has twice asked the State Department to issue a license—and both times has received a refusal.

"As a result we have lost about $3 billion in the last five years alone.

"The Americans are putting pressure on us to abandon certain joint projects involving the transfer of space technology to India, which has no desire to join the Treaty on the Nonproliferation of Nuclear Weapons.

"Yet they themselves the other day offered India military satellites and modern aircraft in exchange for the right for U.S. military ships and submarines to put in at Indian ports...."

Incidentally

It is now apparent that we did not sell a working Topaz, but a display model. Having bought this for $7.5 million, the Pentagon, after carrying out tests on it, expects to obtain economic benefits to the tune of hundreds of millions of dollars.

Foreign Ministry Official Cited on Rocket Sales to India, MTCR Problem

OW2704130192 Moscow INTERFAX in English 1245 GMT 27 Apr 92

[By reporters M. Mayorov, I. Porshnev, and others from "Diplomatic Panorama"; transmitted via KYODO]

[Text] According to information available to DP [Diplomatic Panorama], Russia and India are engaged in consultations on the issue of exporting Russian rocket technology to India. As a Foreign Ministry expert interviewed by DP's correspondent said, these consultations are designed to alleviate the anxiety of participants in the regime of control over rocket technology [Missile Technology Control Regime—MTCR] Russia declared its willingness to join, on the one hand, and, on the other, ensure a further development of cooperation between Russia and India.

Russia is not inclined to violate the regime's requirements, but it wishes to avoid actions fraught with jeopardizing its relations with India.

The Foreign Ministry expert referred to President Boris Yeltsin's statement at the U.N. on January 29, when he proclaimed Russia's intention to join the regime of control over rocket technology which, as a matter of fact, is not universal yet.

It's common knowledge that the Russian Committee on Space Research and the Indian Space Research Organization signed an agreement under which Russia undertook to supply India with space machinery, such as engines for the final stages of booster rockets.

According to the diplomat, cooperation between Russia and India in this area has always pursued purely peaceful goals. Booster rocket equipment supplied to India is designed exclusively for the peaceful use of outer space.

Nevertheless some of Russia's partners, in particular the U.S., believe that the agreement between Russia's Space Research Committee and India's Space Research Organization conflicts with the regime of control over rocket technology.

"Russia doesn't think so, even though it concedes that there are serious nuances in this area which ought to be discussed", the Foreign Ministry expert pointed out. At

present, he said, Russia is in contact with the Americans who claim the role of the regime's monitors, and with the Indians who are interested in supplies of Russian booster rocket technology.

In the meantime the Russian leadership decided to suspend the deliveries of booster rocket machinery to India and conduct consultations with Delhi. "This process is going on, and it should be neither simplified nor dramatized", the diplomat said.

Russian State Secretary Burbulis To Discuss Rocket Deliveries

OW2804132092 Moscow INTERFAX in English 1252 GMT 28 Apr 92

[By reporters M. Mayorov, I. Porshnev, and others from "Diplomatic Panorama"; transmitted via KYODO]

[Text] As DP [Diplomatic Panorama] learned from well-informed sources in Russia's Foreign Ministry, Secretary of State Gennadiy Burbulis will visit India on May 3-5.

According to a prominent Foreign Ministry official, the visit to Delhi by G. Burbulis does not rule out a visit by President Boris Yeltsin. "The Russian leader's trip is still on the agenda, even though its timing is to be coordinated yet", the diplomat said. According to him, B. Yeltsin might go to India at the end of this year, though the exact date will depend on the President's work schedule.

The agenda of G. Burbulis' talks in Delhi is "open". It might include negotiations on the possibility of further deliveries of Russian space equipment to India.

It's common knowledge that Russia declared its intention to join in the near future the regime of control over rocket technology. Hence it decided to suspend such deliveries and hold corresponding consultations with Delhi, even though bilateral cooperation in this area is purely peaceful.

This problem began to be discussed recently, when Moscow was visited by U.P. Rao, a leading member of India's space research department. His trip was planned long ago and was not prompted by an emergency, though some experts believe that the Russian authorities' decision to suspend the exports of space equipment to India accelerated U.P. Rao's arrival.

U.P. Rao met with the leaders of Russia's space research committee and discussed the emergence of problems with them. According to information available to DP, discussions were held in a calm atmosphere. Even though a final solution was not reached, the two sides confirmed their willingness to search for a compromise. "Neither we nor the Indians are inclined to dramatize the situation", said the Foreign Ministry official who preferred to remain anonymous.

Concern Over Possible U.S. Aid Cutoff

927Q0163 Moscow IZVESTIYA in Russian 16 May 92 Morning Edition 3A

[Yevgeniy Bay report: "Russia Risks Being Left Without American Assistance Over the Sale of Rocket Engines to India"]

[Text] **M. Tutwiler, official U.S. State Department spokesperson, declared on Thursday: The U.S. Administration is working with Senator Joseph Biden at this time on clarification of the content of his amendment to the bill on aid to Russia.**

The day before, Wednesday, the key Senate Foreign Relations Committee opposed economic assistance being granted Russia if Moscow goes ahead with the supply to India of rocket engines. We would note that it voted unanimously 19:0 and raised several important conditions on the $24 billion aid package being granted Russia.

While talk continues in Moscow as to the expediency of the sale of this type of rocket engine or the other to India, and government spokesmen angrily fulminate against representatives of the press for allegedly "inflaming passions" (only Glavkosmos, the officials say, not all of Russia, is threatened with sanctions), the "lack of mutual understanding" between Russia and the United States in connection with the rocket contract is threatening to develop into a serious conflict which could cancel out what the Ye. Gaydar reform government has managed to push through with such difficulty.

It is hard to say what our government officials are thinking on this subject (the more so in that we have not had an opportunity to hear their opinion following the Senate committee vote), but the Americans, by all accounts, are in a very decisive frame of mind. Senator Joseph Biden declared at the hearings: "I hope Russia's leaders recognize that it would be wise on their part to suspend the rocket deal in the face of the danger of loss of the entire economic aid package." And, commenting on the rocket contract, he observed: "This is not some two-bit deal. All this is very dangerous."

In this case it is not a question of whether our contract with India is indeed a violation of international agreements and of whether we should unconditionally submit to the Americans' demands, although the heart of the matter needs to be closely investigated. But of one thing there is no doubt: The United States is seriously worried, and we are compelled to affirm this concern.

IZVESTIYA warned more than a week ago, incidentally, that we were running the risk of losing American economic assistance overnight. And were such a thing to happen, this would be the result of an insufficiently considered policy and an inability to resolve such complex questions in a balanced and comprehensive fashion.

It has been noticed that in the past two or three days (following the reassuring explanation that only Glavkosmos would be punished) not only has the press or television in fact not commented, but also not reported on a question of key significance for the fate of Russia. Is self-censorship taking effect once again? Are we afraid of offending the government?

Meanwhile Ambassador Richard Armitage, coordinator of American assistance to the CIS states, who spoke at the hearings, although expressing concern as regards the way in which J. Biden's amendment was worded, did not take exception to it in principle.

Of course, J. Biden's amendment, about which M. Tutwiler spoke yesterday, will be carefully analyzed by the administration, but the unanimous Senate committee vote makes it possible to assume with a greater or lesser degree of probability that the economic aid package to Russia will be blocked by the U.S. Congress.

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